PB90-910209

SELECTED
WATER
RESOURCES
ABSTRACTS

VOLUME 23, NUMBER 9
SEPTEMBER 1990

W90-07507 -- W90-08643
CODEN: SWRABW

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PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
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Reston, VA 22092

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SUBJECT FIELDS AND GROUPS

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Includes the following Groups: Properties; Aqueous Solutions and Suspensions.

02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

08 ENGINEERING WORKS

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09 MANPOWER, GRANTS, AND FACILITIES

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10 SCIENTIFIC AND TECHNICAL INFORMATION

Includes the following Groups: Acquisition and Processing; Reference and Retrieval; Secondary Publication and Distribution; Specialized Information Center Services; Translations; Preparation of Reviews.

SUBJECT INDEX

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SELECTED WATER RESOURCES ABSTRACTS

1. NATURE OF WATER

1A. Properties

IONIC COMPOSITION OF RESERVOIR WATER IN BOHEMIA: LONG-TERM TRENDS AND RELATIONSHIPS.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
L. Prochazkova, and R. Blazka.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 323-330, 1989. 4 fig, 2 tab, 23 ref.

Descriptors: *Acid rain, *Acid rain effects, *Chlorides, *Czechoslovakia, *Nitrates, *Path of pollutants, *Reservoirs, *Sulfates, *Water pollution, *Water pollution sources, *Water quality trends, Agricultural chemicals, Agricultural runoff, Air pollution, Bicarbonates, Bohemia, Fertilizers, Weathering.

During the last 28 years the ionic composition of surface waters in Bohemia, Czechoslovakia has changed substantially. Instead of a dominance of hydrogen carbonate, which was typical in the first decades of this century, the anions of strong acids now prevail by roughly a factor of three. The sources of SO4(--), NO3(-), and Cl(-) are the outputs from agricultural areas, as the fertilizers used contain also large quantities of sulfates and chlorides. The concentrations of all three ions were positively related to flow rate. The inputs of S and N from the atmosphere may also be substantial. For example, in the Slapy Reservoir water in the last quarter-century gradual changes of ionic composition have been demonstrated. The equivalent concentration of the sum of ions has doubled. The percentage of all anions of strong acids has increased, for example, in the case of sulfates from 30% to 50%. The percentage of hydrogen carbonate has decreased from 50% to 22%, while its absolute concentration remained nearly unchanged. The equivalent ratio of anions of strong acids to anions of weak acids has increased from 1 to 3. The percentage share of individual cations remained without significant changes. Similar changes have been found in three other reservoirs in Bohemia. It is suggested that the main sources of these changes are the outputs from fertilized farmland, inputs form the atmosphere, and the increased weathering rate due to increased acidic atmospheric inputs. (Mertz-PTT)
W90-07739

2. WATER CYCLE

2A. General

ENGINEERING HYDROLOGY TECHNIQUES IN PRACTICE.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W90-07548

HYDROLOGY AND WATER QUANTITY CONTROL.
University of Central Florida, Orlando. Dept. of Civil Engineering and Environmental Sciences.
M. P. Wanielista.
John Wiley and Sons, New York. 1990. 565p. Includes one 5-1/4 inch floppy disk with hydrology programs to accompany the text.

Descriptors: *Computer programs, *Hydrology, *Water resources development, *Water supply, Data acquisition, Evapotranspiration, Flood peak, Groundwater, Hydrographs, Hydrometeorology, Infiltration, Precipitation, Statistical methods.

Hydrology is the major discipline used to understand and design water management systems that are directly and indirectly related to the occurrence of water on, above, and below the earth's surface. In this text, methods for measurement and methodologies for the description and prediction of hydrologic processes are presented. Because processes vary with time and change with geographic location, the quantities (volume and rate) of each process resulting from modifications to other hydrologic processes and land use conditions are the fundamental considerations in this text. Chapter 1 presents information concerning the content and organization of the text. Following chapter headings include: meteorology and the hydrologic cycle; precipitation; infiltration and evapotranspiration; streamflow measurements; hydrographs; synthetic hydrographs; flow routing; probability and statistics for hydrologic descriptors; groundwater hydrology; and, volume and peak discharge management. To enforce the concepts and ideas of each chapter, some example problems are solved and then additional problems are found at the end of each chapter. The end-of-chapter problems recognize the complexity of hydrologic systems and provide repetition to learn problem-solving procedures. The computer programs on a diskette included with this book serve as teaching aids in addition to being computation aids. One computer diskette is provided. (Lantz-PTT)
W90-07554

MULTIVARIATE GEOSTATISTICAL APPROACH TO SPACE-TIME DATA ANALYSIS.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-07669

WATER FLOW PATHS AND HYDROCHEMICAL CONTROLS IN THE BIRKENES CATCHMENT AS INFERRED FROM A RAINSTORM HIGH IN SEASALTS.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
J. Mulder, N. Christophersen, M. Hauhs, R. D. Vogt, and S. Andersen.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 611-622, April 1990. 11 fig, 2 tab, 21 ref.

Descriptors: *Acid rain, *Aluminum, *Forest watersheds, *Norway, *Sulfates, Flow pattern, Hydrogen ion concentration, Hydrologic models, Lateral flow, Soil chemistry, Solubility.

At Birkenes, a small forested catchment with acidic soils in southernmost Norway, acid rain has resulted in high stream water hydrogen ion, aluminum, and sulfate concentrations. Recent studies have revealed the complexity of the aluminum chemistry in Birkenes stream water, as inorganic aluminum is not regulated by one single solubility control. It has been hypothesized that this is due to the dynamic nature of water flow paths and the different aluminum solubilities in surface soils and subsoils. In this study the flow path hypothesis as well as cation solubility controls were tested, using soil solution lysimetry, before and after a storm event, exceptionally high in sea salts. Results indicate that considerable lateral flow through the organic surface layers to the stream did occur during rainstorms on nearly water-saturated soils. In the organic surface horizons, aluminum concentrations were reduced and controlled by cation exchange, whereas in the mineral B horizons, aluminum was more soluble and close to equilibrium with gibbsite. (Author's abstract)
W90-07671

LONG-TERM WATER BALANCES FOR SUBCATCHMENTS AND PARTIAL NATIONAL AREAS IN THE DANUBE BASIN.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
M. Domokos, and J. Sass.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/4, p 267-292, January 1990. 8 fig, 3 tab, 8 ref.

Descriptors: *Danube River Basin, *Hungary, *Hydrologic budget, *Watershed management, Catchments, Evapotranspiration, Mapping, Precipitation, Rainfall-runoff relationships, Runoff.

The simplest type of multi-annual water balance, expressing the equilibrium of precipitation P versus evapotranspiration E plus runoff R, has been compiled for the period 1931-1970, first for 47 sub-catchments and then for twelve partial national areas, as balance units, for the Danube Basin. For each of these units the regional average values of the three balance components, expressed in mm/yr, have been determined by transforming the hydrological isoline maps (scale: 1:2,000,000), printed in 1984 in Budapest, into planimetric maps. The errors of balance do not exceed +or-5%, with a few exceptions. As hydrologic characteristics, the runoff coefficients have been calculated for each balance unit both individually and as a longitudinal function of the whole Danube. The longitudinal function also includes the (cumulative) regional average values of precipitation and the runoff for the catchment belonging to any arbitrary Danube section. With the help of this longitudinal profile it was possible to compare the discharges derived from the runoff isoline map with the corresponding values calculated from observed data series of Danube gages. On the basis of the results obtained, it can be stated that the isoline maps, printed beforehand in 1984 as annexes to the Danube Monograph, reflect the regional distribution of long-term average values of the water balance elements in compliance with reality and in comprehensible interrelation. Both the maps and the data in the balance tables derived may be recommended as internationally coordinated basic information, reflecting the present level of knowledge. (Author's abstract)
W90-07726

GLOBAL HYDROLOGIC AND ENERGY CYCLES: SUGGESTIONS FOR STUDIES IN THE PRE-GLOBAL ENERGY AND WATER CYCLE EXPERIMENT (GEWEX) PERIOD.
Maryland Univ., College Park. Dept. of Meteorology.
For primary bibliographic entry see Field 7A.
W90-07818

HYDROLOGY OF THE CASTLE LAKE BLOCKAGE, MOUNT ST. HELENS, WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 8D.
W90-07859

WATERSHED SCALE RAINFALL INTERCEPTION ON TWO FORESTED WATERSHEDS IN THE LUQUILLO MOUNTAINS OF PUERTO RICO.
Institute of Tropical Forestry, Rio Piedras, PR.
For primary bibliographic entry see Field 2E.
W90-07979

SIMULATION OF SNOWMELT RUNOFF PATHWAYS ON THE LAC LAFLAMME WATERSHED.
Moncton Univ. (New Brunswick). Ecole de Sciences Forestieres.
For primary bibliographic entry see Field 2C.
W90-07980

FLOOD ESTIMATION IN INDIAN CATCHMENTS.
Indira Gandhi National Open Univ., New Delhi (India).
For primary bibliographic entry see Field 7C.
W90-07982

KINEMATIC FLOW APPROXIMATION TO RUNOFF ON A PLANE: SOLUTION FOR INFILTRATION RATE EXCEEDING RAINFALL RATE.
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
G. C. Sander, J. Y. Parlange, W. L. Hogarth, C. W. Rose, and R. Haverkamp.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 193-206, February 1990. 7 fig, 9 ref.

Descriptors: *Infiltration rate, *Kinematic flow, *Rainfall rate, *Rainfall-runoff relationships,

Group 2A—General

*Runoff, *Unsteady flow, Excess rainfall, Hydraulic conductivity.

When rainfall falls below the infiltration rate, the excess rainfall r(t) becomes negative. A general analytical solution to the kinematic flow approximation is presented for an excess rainfall rate which approaches the negative value corresponding to the saturated hydraulic conductivity for very large times. This solution simplifies an earlier solution given to the same problem. Because of the simpler formulation accurate expansions can be derived for the water profiles for different limits during the runoff event. As r(t) passes through zero the relationship between distance and depth is very nearly linear and the functional form of the excess rainfall, which leads to straight line water profiles in general, can be determined. (Author's abstract)
W90-07986

PROGRAM PLAN AND SUMMARY–REMOTE FLUVIAL EXPERIMENTAL (REFLEX) SERIES: RESEARCH EXPERIMENTS USING ADVANCED REMOTE SENSING TECHNOLOGIES WITH EMPHASIS ON HYDROLOGIC TRANSPORT, AND HYDROLOGIC-ECOLOGIC INTERACTIONS.
Department of Energy, Washington, DC. Div. of Ecological Research.
For primary bibliographic entry see Field 7B.
W90-08164

REGIONAL RELATIONSHIPS BETWEEN GEOMORPHIC/HYDROLOGIC PARAMETERS AND SURFACE WATER CHEMISTRY RELATIVE TO ACIDIC DEPOSITION.
NSI Technology Services Corp., Corvallis, OR.
B. P. Rochelle, C. I. Liff, W. G. Campbell, D. L. Cassell, and M. R. Church.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 103-120, December 1989. 3 fig, 7 tab, 35 ref.

Descriptors: *Acid rain, *Alpine regions, *Forest watersheds, *Hydrologic properties, *Regional analysis, *Surface-groundwater relations, *Water chemistry, Catchment basins, Correlation analysis, Geomorphology, Hydrograph analysis, Inorganic compounds, Land use, Physiographic provinces, Runoff, Soil properties, Statistical analysis, Sulfur, Surface water data, Topographic mapping.

Geomorphic and hydrologic parameters were determined for 144 forested, lake watersheds in the Northeast (NE) of the United States based primarily on measurements from topographic maps. These parameters were used to test for relationships with selected surface water chemistry relevant to acidic deposition. Analyses were conducted on regional and subregional scales delineated based on soils, land use, physiography, total sulfur deposition and statistical clustering of selected geomorphic/hydrologic parameters. Significant relationships were found among the geomorphic/hydrologic parameters and the surface water chemistry, particularly in the mountainous areas of the NE. Other factors occurring consistently as significant predictors of surface water chemistry were maximum relief, relief ratio, runoff, and estimates of basin elongation. Results suggest that elevational parameters might be surrogates for other watershed characteristics, such as soils or spatial deposition patterns. Stream order was a significant class variable with lower order systems tending to be associated with low pH and acid neutralizing capacity high sulfate and total aluminum. Analysis at the sub-regional level improved the correlations among the descriptive parameters and surface water chemistry over the findings for the total NE. This improvement in correlation is probably due to reduced heterogeneity within the data at the sub-regional level. Also, stratifying the data based on factors such as soils and sulfur deposition removes some of the influence these factors have on surface water chemistry. (Author's abstract)
W90-08220

PHYSICALLY BASED FLOOD FEATURES AND FREQUENCIES.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-08253

CASE STUDY EVALUATION OF GEOMORPHOLOGIC RAINFALL-RUNOFF MODEL, INCORPORATING LINEAR INFILTRATION EXPRESSION.
Cairo Univ., Giza (Egypt). Dept. of Irrigation and Hydraulics.
M. N. Allam.
Hydrological Processes HYPRE3, Vol. 4, No. 1, p 71-84, January/March 1990. 3 fig, 6 tab, 19 ref. King Abdulaziz City for Science and Technology Grant AR-07-85.

Descriptors: *Geomorphology, *Infiltration coefficient, *Model studies, *Rainfall-runoff relationships, *Unit hydrographs, *Watersheds, Case studies, Mathematical models, Performance evaluation, Rainfall distribution, Saudi Arabia, Stream discharge.

Recently, a method for estimating the Instantaneous Unit Hydrograph (IUH) has been developed, derived as a function of watershed geomorphology and stream response to lateral inflows. This response was determined by solving one-dimensional linearized equations of motion including a simple infiltration expression approximated by an infiltration coefficient multiplied by the streamflow discharge. Three gauged watersheds in Saudi Arabia with different sizes are selected as case studies. Disagreement between the simulated and observed hydrographs has been found for two of the study areas. This disagreement has been related to the conditions of the spatial rainfall distribution in the study areas, the incorporated linear infiltration expression in the Hydraulically-based Geomorphologic IUH (HGIUH), and the model basic assumptions. Improvement of the infiltration presentation in the model should enhance the model predictability. It will also enable analysis of the separate effect of the HGIUH basic assumptions on the model results. (Author's abstract)
W90-08329

PATTERN OF SOLUTE MOVEMENT FROM SNOW INTO AN UPPER MICHIGAN STREAM.
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
R. Stottlemyer, and D. Toczydlowski.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 290-300, February 1990. 10 fig, 4 tab, 28 ref.

Descriptors: *Acid rain, *Ammonium, *Hydrogen, *Chemistry of precipitation, *Path of pollutants, *Snowmelt, *Solute transport, *Water pollution sources, Lake Superior, Michigan, Mineralization, Nitrates, Nitrification, Potassium, Snowpack, Streams, Sulfates, Water chemistry, Watersheds.

Precipitation, snowpack, snowmelt, and streamwater samples were collected in a small gauged watershed draining into Lake Superior during winter 1987-88 to assess the importance of snowmelt pattern and meltwater pathways in the occurrence of solute pulses in streamwater. The snowpack along the southern shore of Lake Superior can contain 50% of annual precipitation inputs and 38% of annual ionic inputs including moderate levels of strong acids. Throughout winter, thawed surface soils and small but steady snowpack moisture release promoted movement of snowpack solutes to surface mineral soils. Preferential elution of K(+), NH4(+) and H(+) from the snowpack occurred with the initial thaw. Most ions exhibited pulses in snowmelt. Transport of snowpack solutes to the stream during snowmelt was through near-surface soil macropores and overland flow. For those ions with concentrations higher in the snowpack than in the premelt streamwater, K(+), NH4(+) and H(+), the earliest snowmelt pulses had the greatest influence on streamwater chemistry. Unlike other portions of the region with resistant bedrock, the widespread presence of alkaline glacial till provides excess stream acid neutralization capacity (ANC) to buffer acidic inputs. Peak winter streamwater ANC reduction was caused principally by spring melt dilution of base cations and associated alkalinity, constant high SO4(2-) levels, and an increase in NO3(-). The maximum reduction in stream ANC was concurrent with overland flow. Relative to its snowmelt concentration, NO(3-) was highest in streamwater with some input likely the result of nitrification and N mineralization. (Author's abstract)
W90-08434

HYDROLOGY.
Finkel and Finkel, Yoqneam (Israel).
H. J. Finkel, and M. Finkel.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 5-26, 7 fig, 8 tab, 12 ref.

Descriptors: *Israel, *Rainfall-runoff relationships, *Semiarid lands, Arava Valley, Flood peak, Hydrological regime, Mathematical studies, Rainfall, Runoff, Streamflow.

A hydrologic study of the Arava Valley in Israel is presented in some detail as an illustration of a method relevant to other similar regions of low rainfall, intermittent stream flow, and broken, hilly topography. General conclusions are the following: (1) If the average occurrence of floods from several nearby watersheds follows a Poisson distribution they may be considered as part of a single population, at least insofar as probabilities of flood occurrences are concerned; (2) Peak flows, whether long-term average annual or of any given probability of occurrence, generally follow the following relationship: peak flows = KA(b), where K is a constant expressing the probability of recurrence, and b is an exponent closely approximating 0.6 to 0.7.; (3) the relations between peak flow and flood volume, have a high linear correlation because the flood durations vary over a relatively small range, and the hydrographs have a fairly standard shape factor; (4) for watersheds of widely varying catchment areas there was a fairly constant relationship between peak flow/average flow, and the probabilities of occurrence; (5) the cumulative runoff from all of the 'point areas' represents the bulk of the water which begins as surface flow. Most of the difference between this and the measured volume of the flood at the downstream point of measurement represents loss of water in the main channels, most of which eventually represents the amount of aquifer recharge; and (6) the long-term average annual runoff coefficient for the larger catchments is small, and may range from 1 to 2%. For the so-called 'point areas' it may reach ten times this figure. (See also W90-08532) (Lantz-PTT)
W90-08533

WATER BUDGET AND PHYSICAL HYDROLOGY.
Nevada Univ. System, Las Vegas. Water Resources Center.
J. W. Hess, and W. B. White.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 105-126, 8 fig, 8 tab, 15 ref.

Descriptors: *Groundwater movement, *Hydrologic budget, *Hydrologic properties, *Karst hydrology, *Kentucky, Aquifers, Evapotranspiration, Geohydrology, Precipitation, Rainfall-runoff relationships, River flow, Runoff, Springs.

Existing river-flow and precipitation records, combined with additional precipitation data from a rain gage network and additional observations on spring discharges and spring specific conductance and temperature, allow a few general conclusions to be drawn about the hydraulic response of the shallow karstic-carbonate aquifer in south-central Kentucky. Evapotranspiration is lower, and runoff is higher for the karst area than for other parts of the Green River basin by 10-15%. This effect results from rapid movement of water underground through sinkholes and sinking streams with consequent reduced opportunity for evaporative and transpirational losses. The runoff is an underground runoff. Normalized base flow from the karst springs is almost an order of magnitude lower than for other drainage basins. The low-gradient

open conduits drain quickly and retain less water in storage. To within the error of measurement, all groundwater discharge from the karstic conduit aquifer can be accounted for by the large springs. Diffuse flow within the aquifer must be directed toward the conduits that provide a groundwater trough rather than leading to the river. High-resolution plots of specific conductance and temperature for the Turnhole Spring drainage system, in response to high intensity storms, shows that the overall response time of the aquifer to a storm event is about 2 weeks. The existence of well-defined tributaries on the drainage line is revealed by sharp peaks and dips on the conductivity curve. Data at present are insufficient to translate these into specific details of conduit geometry. (See also W90-08542) (Lantz-PTT)
W90-08546

CONFERENCE ON CLIMATE AND WATER. VOLUME I.
September 11-15, 1989. Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. 520 p.

Descriptors: *Climates, *Climatology, *Conferences, *Europe, *Global warming, *Greenhouse effect, *Hydrology, *Water resources management, Aquatic environment, Comprehensive planning, Policy making, Socio-economic activities, World Meteorological Organization.

The World Meteorological Organization (WMO) convened a conference concerned with climate, hydrology and water resources with the focus on Europe and adjacent regions, within the context of the World Climate Programme. The aim of the conference was to bring together experts involved with climate variability and change and their impact on hydrology and water resources from an area rich in hydrological records but where water resources are under stress. The improved understanding of the interrelationship between climate and water will provide a better basis for developing national plans to counteract any negative impact of climate on water resources. The principal topics of the conference were: (1) the current understanding of the global climate, its variability and potential for change; (2) the effect of climate variability and change on the aquatic environment and on the hydrological cycle; (3) impacts on various water related socio-economic activities; and (4) the policy options that could lead to various policies that may be followed at national, regional or international levels in response to the possible impacts. (See W90-08566 thru W90-08604) (White-Reimer-PTT)
W90-08565

PROJECTED CLIMATIC CHANGES AND IMPACTS IN EUROPE DUE TO INCREASED CO2.
Muenster Univ. (Germany, F.R.). Center for Applied Climatology and Environmental Studies.
For primary bibliographic entry see Field 2B.
W90-08567

LONG TERM VARIATIONS OF THE WATER BALANCE IN SWEDEN--A PRELIMINARY STUDY.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
T. Jutman, S. Bergstrom, and B. Eriksson.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 103-110, 5 fig, 3 ref.

Descriptors: *Climatology, *Hydrologic budget, *Hydrologic data, *Sweden, Biomass, Forest watersheds, Hydrologic models, Precipitation, Runoff, Seasonal variation, Statistical analysis.

A preliminary statistical analysis of records of precipitation, runoff, and forest biomass was made to detect trends and interactions. Because of the risk of inconsistencies in the data the analysis was mainly restricted to the period 1945-1987. The results indicate a possible increase of evapotranspiration due to increasing forest biomass. It was found that an increase in precipitation is not always

followed by increasing runoff. One complicating factor is that no discrimination was made between winter and summer precipitation. Winter precipitation is more effective on runoff as a lot of the summer precipitation will be used to refill a high soil moisture deficit. On the other hand winter precipitation suffers more from aerodynamic losses at the rain gage. Some of the uncertainties could be overcome if a hydrological model were used in the analysis. (See also W90-08565) (White-Reimer-PTT)
W90-08570

MEDITERRANEAN OSCILLATION: IMPACT ON PRECIPITATION AND HYDROLOGY IN ITALY.
Servizio Meterologico dell'Aeronautica, Rome (Italy).
For primary bibliographic entry see Field 2B.
W90-08572

ATMOSPHERIC TRANSPORT OF HEAT AND WATER: A REVIEW.
Helsinki Univ. (Finland). Dept. of Meteorology.
E. O. Holopainen.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 149-157, 1 fig, 20 ref.

Descriptors: *Atmospheric circulation, *Atmospheric physics, *Atmospheric water, *Heat transfer, *Meteorology, Aerological method, Data collections, Data processing, Energy, Evaporation, Precipitation, Residual method, Satellite technology, Validation, Variability.

Recent studies of atmospheric cycles of water and energy based on the use of atmospheric circulation data are reviewed. Applications of the 'aerological method' of determining the difference between surface evaporation and precipitation, as well as those of the 'residual method' of inferring the distribution of diabatic heating in the atmosphere are considered. It appears that recent developments in meteorological data assimilation methods have considerably improved the usefulness of these methods. The validation of the estimates of total atmospheric energy source against satellite measurements of net radiation showed that in the northern hemisphere, where data coverage is best, the two estimates are in good agreement. However, the agreement is less good south of about 25 degrees N, where the density of the basic observations is less satisfactory. A key issue in future descriptions of the atmospheric energy and water cycles is the use of and adequate data assimilation system to analyze the meteorological, hydrological, and oceanographic observations of various kinds. Such a system will ultimately provide the best global distributions not only for circulation variables (such as pressure, wind and temperature) but also for the small-scale fluxes that play an important role in these cycles. (See also W90-08565) (White-Reimer-PTT)
W90-08574

VALIDATION OF RESIDUAL ENERGY BUDGETS FROM ATMOSPHERIC CIRCULATION DATA AGAINST SATELLITE MEASUREMENTS OF THE NET RADIATION.
Helsinki Univ. (Finland). Dept. of Meteorology.
C. Fortelius.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 158-166, 4 fig,1 tab, 7 ref.

Descriptors: *Atmospheric circulation, *Atmospheric physics, *Climatic data, *Climatology, *Energy, *Hydrologic cycle, *Meteorology, *Radiation, *Weather, Europe, Heat flux, Residual energy budget, Residual method, Satellite technology, Validation.

The distributions of the net sources of atmospheric dry and latent energy are evaluated by the residual technique, using the re-analyzed European Centre For Medium Range Weather Forecasts FGGE level IIIb data for February and July 1979. Their

sum (i.e. the estimated source of total energy) is compared to simultaneous Nimbus 7 earth radiation budget estimates of the radiation balance at the top of the atmosphere. Formally the difference between the two equals the net heat flux through the earth's surface. Over land the estimated total energy source should be nearly equal to the radiation balance. The best agreement is found in July 1979 over the northern hemisphere middle latitudes, where monthly averages over large land-areas agree to within 10 W/sq m. In February, the residual is systematically too large by 20-40 W/sq m over the same regions. Elsewhere, differences of up to 60 W/sq m occur for corresponding averages. Over low latitude continents, the residuals are generally too small over convectively active regions and too large over subsidence regions. Over the oceans the difference between the net radiation and the total energy source compares favorably with available estimates of the climatological heat flux through the surface. The same is true for the residual source of latent energy and the fresh water flux through the surface. (See also W90-08565) (Author's abstract)
W90-08575

CHARACTERIZATION OF HYDROMETEOROLOGICAL ELEMENTS.
Budapesti Mueszaki Egyetem (Hungary). Dept. of Water Supply Management.
J. Winter.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 177-186, 6 fig, 4 ref.

Descriptors: *Climatic changes, *Global warming, *Hungary, *Meteorology, *Precipitation, *Temperature, Humidity, Light intensity, Meteorological data, Wind.

Studies done for the northern part of Hungary at the weather-station in Miskolc do not support the warming trend and lack of precipitation found in the climate studies for the world in general. A difference of 4 degrees was demonstrated and there are some specific periods that can be observed, but taking into consideration the 65 year period no significant trend is obvious. The same result is found when examining the relative moisture content/humidity in the air. Within five year increments of rainfall observation at Kompolt the periods appear more sharply, but when the entire 90 years are taken into consideration a definite trend is not observed. These characterizations were made using the monthly mean values for temperature, sunshine duration, air humidity, amount of wind, and precipitation. (See also W90-08565) (White-Reimer-PTT)
W90-08577

HYDROLOGICAL MODELING OF HAPEX REGION USING SATELLITE OBSERVATIONS.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
C. Ottle, and D. Vidal-Madjar.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 272-280, 4 fig, 10 ref.

Descriptors: *France, *Hydrologic models, *Remote sensing, *Satellite technology, *Soil water, Evaporation, Groundwater, Infiltration, Precipitation, Runoff, Surface water, Watersheds.

The hydrological model of the 'Ecole Superieure des Mines', implemented for the HAPEX-MO-BILHY region of southwestern France, has been used to follow the hydraulic budget of soils by using remote sensing data at a large scale (5x5 sq km) for a two year period (1985-1986). This model computes both underground and surface water flows and includes one storage layer where the budget between precipitation, potential evaporation, surface runoff and infiltration is done. However, in order to follow the hydraulic budget at the surface, evaporation and precipitation have to be known precisely, and remote sensing can be very

Group 2A—General

useful to improve their estimation. Many studies have shown that surface temperature estimated from satellite observations can be inversed to restore land surface parameters and fluxes, especially evaporation and soil humidity. If these quantities are estimated each time there is a cloudless image over the region, the hydrological model can be reinitialized regularly. The results show that if the vegetation parameters can be calibrated precisely, the comparison of simulated and satellite radiative temperature will make estimates of the spatial and temporal variations of the soil moisture as well as mapping of surface fluxes at a large scale possible. (See also W90-08565) (Author's abstract)
W90-08585

EFFECTS OF CLIMATE VARIABILITY AND CHANGE ON FRESH WATER BODIES.
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
H. Liebscher.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 365-391, 1 fig, 1 tab, 72 ref.

Descriptors: *Climatic changes, *Global warming, *Greenhouse effect, *Lakes, *Rivers, *Surface water, Air temperature, Carbon dioxide, Information exchange, Mathematical models, Regional variation, Water level, Water resources management, World Climate Program.

An overview of the possible impacts of climatic changes on surface waters and on the planning of water-resources systems is presented. At the present time the assumption generally considered is that a two-fold increase in the CO2 content in the earth's atmosphere will result in an annual mean air temperature increase between 1.5 and 5.5 C by the middle of the next century. Simultaneously, a rise in the sea level between 20 and 160 cm is presumed. The effects of this projection are evaluated in regard to: (1) impacts of climatic changes on surface water and on water resources management; (2) surface water related projects of the World Climate Program (WCP)--water; (3) reconstruction of discharge, river stage and water level series from historical records; (4) investigation of climate variability in long-term data sets of drainage and water level; (5) investigation on regional variability of surface water; and (6) mathematical models for investigating the impact of climatic changes on surface water. For investigating the spatial variability of the impacts of climatic changes on surface water a wide data base is required. For this purpose existing international data banks or data collections must be completed and widened. An international organizations program for an increased data exchange among the different countries ought to be developed. (See also W90-08565) (White-Reimer-PTT)
W90-08593

JOINT APPLICATION OF TREND TESTING AND HYDROLOGICAL MODELS IN DISTINGUISHING BETWEEN HUMAN INFLUENCES AND CLIMATIC EFFECTS ON THE HYDROLOGICAL CYCLE.
Geological Survey, Reston, VA.
W. M. Alley, J. C. Refsgaard, and V. S. Vuglinsky.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 413-425, 3 fig, 1 tab, 15 ref.

Descriptors: *Climatic changes, *Global warming, *Hydrologic cycle, *Hydrologic models, *Watersheds, Case studies, Flow, Groundwater, Statistical trend-testing.

A methodology has been developed to distinguish trends due to changes in basin characteristics from the effects of climate. The approach involves joint use of hydrological models and a statistical trend-testing procedure. The model is used to explain the fluctuations in the hydrological variable caused by the climatic conditions, and the statistical trend test is applied to the remaining unexplained variability. The methodology incorporates: (1) a systematic, hierarchical model validation scheme; and (2) fur-

ther hydrological analysis as a consistency check on the trend results. The methodology was applied to the Susa project in Denmark. The study area covers about 940 sq km about 50-70 km southwest of Copenhagen. The results showed how the model's ability to explain some of the climate-induced variability increases the power of the statistical test so that the effect of the groundwater abstraction on the annual flows can be detected. (See also W90-08565) (Author's abstract)
W90-08596

ESTIMATING THE IMPACTS OF CLIMATIC CHANGE ON RIVER FLOWS: SOME EXAMPLES FROM BRITAIN.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W90-08597

CLIMATE-INDUCED EFFECTS ON THE WATER BALANCE--PRELIMINARY RESULTS FROM STUDIES IN THE VARPINGE EXPERIMENTAL RESEARCH BASIN.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
R. Berndtsson, M. Larson, G. Lindh, J. Malm, and J. Niemczynowicz.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 437-449, 4 fig, 33 ref.

Descriptors: *Climatic changes, *Experimental watersheds, *Global warming, *Hydrologic budget, *Hydrologic data, Air temperature, Evapotranspiration, Precipitation, Runoff, Soil water, Soil-water-plant relationships, Transpiration.

A preliminary methodology is presented to investigate climate-induced effects on the hydrological cycle. By use of monthly water balances during a ten-year period, it was shown that a future estimated temperature increase and precipitation change will have dramatic effects on the runoff and soil water storage. Based on the simplified assumption that the effects of plant growth and stomatal resistance will counter-balance each other so that the change in transpiration rates is negligible, it was shown that an annual precipitation increase of 20% and an overall annual increase in temperature of 2 C results in a more than 50% increase in annual runoff. It was also shown that an increased precipitation seems to be balanced by an increase in evapotranspiration not affecting the summer soil water storage. However, a decrease in precipitation combined with a temperature increase will have considerable effects on the soil water storage and hence for the availability of plant water. (See also W90-08565) (Author's abstract)
W90-08598

WATER BALANCE INVESTIGATIONS IN SWISS ALPINE BASINS--TOOL FOR THE IMPROVED UNDERSTANDING OF IMPACTS OF CLIMATIC CHANGES ON WATER RESOURCES.
Service Hydrologique National, Bern (Switzerland).
B. Schadler.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 462-475, 2 fig, 1 tab, 10 ref.

Descriptors: *Alpine regions, *Climatic changes, *Global warming, *Hydrologic budget, *Hydrologic data, *Switzerland, *Water resources, Altitude, Experimental watersheds, Geology, Glaciers, Greenhouse effect, Model studies, Precipitation, Runoff.

Runoff-data series collected for a period of 70 to 90 years from 9 small to medium size research basins in different regions of Switzerland were used to assess possible changes in the water balance associated with climatic changes. The different altitude and geology of the basins result in specific hydrological responses, depending on the climatic variation in this century. Water balance components for 450 years were estimated for the

River Rhine from climatological proxy-data and compared with reconstructed runoff-data from water level observations and with precipitation measurements. Within that time period, the recent period seems to be the warmest and the wettest one. Therefore, this recent period is the only one that can give any indications of the changes in water resources due to future potential CO2-induced climate changes. In order to predict climate change induced changes in water resources it is also necessary to consider vegetation, soil structure, glaciated areas, geology and man-made changes in the water-budget models. (See also W90-08565) (White-Reimer-PTT)
W90-08600

GRADUAL CLIMATE CHANGE AND RESULTING HYDROLOGIC RESPONSE.
Illinois State Water Survey Div., Champaign.
K. P. Singh, and G. S. Ramamurthy.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 476-485, 6 fig.

Descriptors: *Climatic changes, *Flood profiles, *Global warming, *Hydrology, *Illinois, *River flow, Air temperature, Data analysis, Flood peak, Flood protection, Levees, Precipitation.

For the last 20 years the northern part of the state of Illinois has been experiencing a wetter and cooler climate than in the past. This climate change has increased river flows and flood peaks, resulting in increased stream bed and bank erosion, higher groundwater levels in levee-protected farmlands, and decreased freeboard for the levees. The 5-year moving averages of annual precipitations for Aurora and Ottawa with records for the period 1901 to the present indicate the possibility of cycles of 100 to 200 years or longer. However such long-term data are not available. Even 20 to 40 years of records for hydrological designs can be inadequate for subsequent periods with significant increases or decreases in precipitation. As a rough guide, the annual change in precipitation is doubly magnified in annual flow and further magnified in flood peaks. There are significant implications for levee design and operation, as well as for flooding and associated loss of property. The climate changes and associated hydrologic changes, as well as implication for various water resource developments, must be carefully investigated and considered before development and operation plans are finalized. (See also W90-08565) (Author's abstract)
W90-08601

EFFECT OF CLIMATE VARIABILITY AND CHANGE ON GROUNDWATER IN EUROPE.
Aarhus Amtskommune (Denmark). Groundwater Dept.
For primary bibliographic entry see Field 2F.
W90-08602

MULTIANNUAL VARIATIONS OF GROUNDWATER IN FINLAND DURING THE YEARS 1962-1989.
National Board of Waters, Helsinki (Finland). Water Research Inst.
For primary bibliographic entry see Field 2F.
W90-08603

2B. Precipitation

RELATION OF WIND FIELD AND BUOYANCY TO RAINFALL INFERRED FROM RADAR.
National Weather Service, Bohemia, NY. Eastern Region.
H. M. Stone.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-208326. Price codes: A03 in paper copy, A01 in microfiche. NOAA Technical Memorandum NWS ER-81, April 1989. 19p, 8 fig, 3 tab, 8 ref.

Descriptors: *Meteorology, *Radar, *Rainfall, *Weather forecasting, *Wind, Data acquisition, Data interpretation, Rainfall intensity.

Wind profile data and stability/buoyancy data were collected from seventeen locations in the Midwest and East where observation sites are co-located with network radar sites. Wind components were computed and linearly interpolated from the standard reporting levels to exactly one thousand foot intervals from the surface to sixteen thousand feet above ground level (AGL). Several measures of wind shear were computed from these wind profiles: the vector product shears VS5, VS10, and VS15, the speed shears SS5, SS10, and SS15 and the shear SHR used in the computation of a Bulk Richardson Number. Direct rainfall data were not used, but precipitation amounts were inferred from radar using accumulated VIP levels over the MDR grid. The relation between radar VIP level and rainfall intensity is not very accurate due to varying drop size distribution in rain clouds, radar attenuation, and various other factors. Nevertheless, high VIP levels are generally associated with heavy rain and low VIP levels with lighter rain. The rather poor relationship between rainfall inferred from VIP levels and hodograph patterns can probably be better ascribed to the variation both in time and space of the wind field. In this study the hodograph at the beginning of the twelve hour period is related to the subsequent persistence of VIP levels observed during a twelve hour period within a 100 nautical mile radius of the radar site. This is a fairly large area and the hodograph could be significantly different away from the radar site, also the time variation in the wind field could be very large over this long a time period. There is a relationship between heavy rainfall events and the wind field, but since raobs are only available twice per day with a large distance between raob sites, it is necessary to estimate the wind profile at the time and place where convection is expected to occur. (Lantz-PTT)
W90-07562

FREQUENCY DISTRIBUTION AND HYDRO-CLIMATIC CHARACTERISTICS OF HEAVY RAINSTORMS IN ILLINOIS.
Illinois State Water Survey Div., Champaign.
F. A. Huff, and J. R. Angel.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-203988. Price codes: A09 in paper copy, A01 in microfiche. Bulletin 70, 1989. 177p, 29 fig, 40 tab, 43 ref, 5 append.

Descriptors: *Chicago, *Climatology, *Frequency distribution, *Illinois, *Rainfall distribution, Hydrometeorology, Precipitation, Rainfall intensity.

Investigation of the distribution of heavy rainstorms in Illinois was based on data for 61 precipitation stations operated during 1901-1983. Frequency distributions of point rainfall are given for periods ranging from 5 minutes to 10 days and for recurrence intervals of from 2 months to 100 years. Results are presented in two forms: mean relations for 10 regions of approximately homogeneous precipitation climate, and statewide isohyetal maps based on the 61-station data. Frequency relations are presented on both an annual and seasonal basis. Results of a special investigation are presented for Chicago and the surrounding six counties subject to urban influences on precipitation distribution. Information is provided on the expected dispersion of point rainfall frequency distributions about the mean in the 10 regions of similar rainstorm climate. Information is also provided on the spatial and temporal characteristics of heavy rainstorms in Illinois. (Author's abstract)
W90-07564

MESOSCALE PRECIPITATION PATTERNS IN EXTRATROPICAL CYCLONES AND IMPLICATIONS FOR CYCLONE DEVELOPMENT.
D. L. Tweedy.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 1987-1997, February 28, 1990. 9 fig, 1 tab, 23 ref.

Descriptors: *Cyclones, *Cyclonic precipitation, *Meteorology, *Precipitation intensity, *Precipitation mapping, *Rainfall distribution, *Rainstorms, *Weather patterns, Convective precipitation, Mesoscale structures, Precipitation generating zones, Rain gages.

Analysis of the surface distribution of precipitation associated with intense extratropical cyclones reveals elongated maxima aligned with the steering flow. Rapidly intensifying cyclones create precipitation maxima which are better defined and contain more moisture than weaker cyclones. The distributions are associated with the formation of a precipitation generating zone (PGZ) aligned with the midtropospheric jet ahead of and parallel to the surface cold front extending southward from the surface low. These zones tend to move along their axes and are host to the most frequent and intense convective activity in the extratropical cyclone. Hourly rain gage measurements at sites in their path indicate an average of three precipitation peaks in 16 storms studied, although radar echoes disclose that many mesoscale structures with high reflectivity are simultaneously active. The hypothesis is that formation of such zones is most pronounced when momentum transport out of the jet increases the advection of warm moist air at low levels, thereby sustaining or increasing convective instability. In this context, the PGZ becomes the dominant feature of the extratropical cyclone and is crucial to intensification. (Author's abstract)
W90-07573

MULTISCALING PROPERTIES OF SPATIAL RAINFALL AND RIVER FLOW DISTRIBUTIONS.
Cooperative Inst. for Research in Environmental Science, Boulder, CO. Center for the Study of Earth from Space.
V. K. Gupta, and E. Waymire.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 1999-2009, February 28, 1990. 3 fig, 1 tab, 50 ref, append. Army Research Office Grant 27772-GS, NSF Grant DMS-8801466.

Descriptors: *Mathematical analysis, *Meteorology, *Probability distribution, *Rainfall distribution, *River flow, *Spatial distribution, *Stochastic models, Mathematical equations, Multiscaling, Stochastic process, Turbulent flow.

Two common properties of empirical moments shared by spatial rainfall, river flows, and turbulent velocities are identified: namely, the log-log linearity of moments with spatial scale and the concavity of corresponding slopes with respect to the order of the moments. A general class of continuous multiplicative processes is constructed to provide a theoretical framework for these observations. Specifically, the class of log-Levy-stable processes, which includes the lognormal as a special case, is analyzed. This analysis builds on some mathematical results for simple scaling processes. The general class of multiplicative processes is shown to be characterized by an invariance property of their probability distributions with respect to rescaling by a positive random function of the scale parameter. It is referred to as (strict sense) multiscaling. This theory provides a foundation for studying spatial variability in a variety of hydrologic processes across a broad range of scales. (Author's abstract)
W90-07574

SPACE-TIME STRUCTURE OF RAIN RATE FIELDS.
Thayer School of Engineering, Hanover, NH.
R. K. Crane.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2011-2020, February 28, 1990. 16 fig, 17 ref.

Descriptors: *Meteorology, *Radar, *Rain gages, *Rainfall distribution, *Rainfall rate, *Remote sensing, *Spectral analysis, Data interpretation, Spatial distribution, Statistical analysis, Statistical methods, Temporal distribution.

Information on the spatial and temporal statistics of rain rate is needed for the design of remote sensing systems for the measurement of areal rainfall accumulation and for the design of millimeter-wave communication systems. In this study, rain gage and radar data were used to determine empirically the spatial and temporal structure of the rain process as observed using rain rate as a tracer

of the atmospheric motions and to test the validity of Taylor's hypothesis for relating their spatial and temporal statistics. Weather-radar-derived rain-rate maps were employed to obtain one and two-dimensional spatial power spectra. Azimuthally averaged two dimensional spectra displayed the shape predicted for a passive scalar advected by a steady state field of two-dimensional turbulence driven by the input of energy over a narrow band of wave numbers. One-dimensional spatial spectra for a short line of rain gages had the same spectral shape as the azimuthally averaged spectra obtained from the radar data. Temporal spectra from the gage time series were nearly identical in shape to the one-dimensional spatial spectra if less than a half hour of data were processed to generate a spectrum and a constant translation velocity was assumed to relate the temporal and spatial scales. For spectra corresponding to longer durations, a match could not be made. (Author's abstract)
W90-07575

MULTIFRACTALS, UNIVERSALITY CLASSES AND SATELLITE AND RADAR MEASUREMENTS OF CLOUD AND RAIN FIELDS.
McGill Univ., Montreal (Quebec). Dept. of Physics.
S. Lovejoy, and D. Schertzer.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2021-2034, February 28, 1990. 3 fig, 51 ref, 2 append.

Descriptors: *Clouds, *Fractal mathematics, *Meteorology, *Precipitation mapping, *Probability distribution, *Radar, *Rainfall distribution, *Remote sensing, *Satellite technology, Mathematical analysis, Multifractals, Radar reflectivity, Universality.

The extreme variability of cloud and rain fields poses serious problems in quantitative use of remotely sensed satellite and radar data. This variability is characterized by using scale invariant (sensor resolution independent) codimension functions which are exponents characterizing the probability distributions. These codimension functions in turn form a three-parameter universality class. The properties of these multifractal measures are reviewed and the codimension functions are empirically evaluated. The universality classes for infrared and visible satellite cloud images are also empirically evaluated by using the new probability distribution/multiple scaling technique, refining previously published results and relating these to the established lognormal rain and cloud phenomenologies. The radar observers' problem for multifractal radar reflectivity factors is solved and the codimension function of rain is estimated from the radar. (Chonka-PTT)
W90-07576

CLUSTERED OR REGULAR CUMULUS CLOUD FIELDS: THE STATISTICAL CHARACTER OF OBSERVED AND SIMULATED CLOUD FIELDS.
Massachusetts Inst. of Tech., Cambridge.
J. A. Ramirez, and R. L. Bras.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2035-2045, February 28, 1990. 10 fig, 5 tab, 20 ref. NASA/NSF Grant 8611458-ATM, NWS Grant NA86AA-D-HY123, OAS Fellowship BEGES-83206.

Descriptors: *Atmospheric physics, *Clouds, *Meteorology, *Simulation analysis, *Spatial distribution, *Statistical analysis, *Statistical models, Atmospheric circulation, Convection, Satellite technology, Thermodynamics.

The spatial distribution of cumulus clouds is assumed to be the result of the effects of convective activity on the thermodynamic environment. These effects can be parameterized in terms of a stabilization function representing the time rate of change of convective available potential energy. Using these results, a new inhibition hypothesis explaining the expected characteristics of the spatial distribution of cumulus clouds is postulated. This paper performs a verification of the inhibition hypothesis on real and simulated cloud fields. In

order to do so, an objective measure of the spatial characteristics of cumulus clouds is introduced. Multiple cloud experiments are performed with a three dimensional numerical cloud model. Skylab pictures of real cumuli are also used in the verification. Results of applying this measure to simulated and observed cumulus cloud fields confirm the inhibition hypothesis. (Author's abstract)
W90-07577

STABILIZATION FUNCTIONS OF UN-FORCED CUMULUS CLOUDS: THEIR NATURE AND COMPONENTS.
Massachusetts Inst. of Tech., Cambridge.
J. A. Ramirez, R. L. Bras, and K. A. Emanuel.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2047-2059, February 28, 1990. 7 fig, 2 tab, 14 ref, 3 append. NASA/NSF Grant 8611458-ATM, NSW Grant NA86AA-D-HY123, OAS Fellowship BEGES-83206.

Descriptors: *Atmospheric physics, *Clouds, *Convection, *Meteorology, *Model studies, *Thermodynamics, Air-earth interfaces, Atmospheric circulation, Convective precipitation, Inhibition hypothesis, Numerical analysis, Spatial distribution, Temporal distribution.

The two fundamental questions were addressed: (1) the possibility of an intrinsic characteristic of free moist atmospheric convection that induces a particular type of space-time structure within cloud fields and (2) the expected nature of the spatial distribution of cumuli within unforced cumulus cloud fields. The thermodynamic effects of convection were quantified as functions of changes of convective available potential energy (CAPE) induced by the convective overturning. The time rate of change of CAPE was parameterized in terms of a kernel of influence or stabilization function. A three-dimensional cloud model was used to infer and quantify stabilization functions by performing single-cloud experiments. Measured stabilization functions were positive everywhere, decreasing away from the cloud center. Stabilization functions were decomposed into various thermodynamic contributions involving pressure, temperature, and moisture changes in the boundary layer and above. It was observed that the major contribution to the environmental stabilization comes from the drying of the planetary boundary layer induced by subsidence. The thermodynamic effect of nonprecipitating and precipitating convection is to reduce CAPE in the surrounding environment and hence reduce the conditional probability of further convection nearby. A new hypothesis with respect to the spatial distribution of cumuli is postulated. The inhibition hypothesis states that, under completely homogeneous external conditions and assuming a spatially random distribution of cloud-triggering mechanisms, the spatial distribution of cumuli in the resulting cloud field must be regular, as opposed to either random or clustered, because cumulus clouds tend to reduce the available energy for convection, thereby inhibiting further convection nearby. (Author's abstract)
W90-07578

IN SEARCH OF REGULARITIES IN EXTREME RAINSTORMS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
E. Foufoula-Georgiou, and L. L. Wilson.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2061-2072, February 28, 1990. 19 fig, 3 tab, 37 ref. NSF Grants CES-8708825 and BSC-8957469.

Descriptors: *Depth-area-duration analysis, *Meteorology, *Rainfall impact, *Rainfall intensity, *Rainstorms, *Statistical analysis, Meteorological data, Meteorological data collection, Spatial distribution, Temporal distribution.

Extreme rainstorms play an important role in the hydrologic design and operation of water resource systems. Due to a lack of complete knowledge of the complex meteorological mechanisms that produce and sustain extreme storms, statistical and correlation analyses are a valuable and complementary tool in identifying regularities of extreme

rainfall characteristics. This paper studied the statistical properties of several characteristics of extreme midwestern storms. In particular, we have analyzed the storm occurrence process in space and time, storm shape and orientation, total storm center depth, storm duration, storm areal extent, and depth-area relationships. Our analysis is based on the data base of extreme storms published by the U.S. Army Corps of Engineers. Several trends and regularities among extreme midwestern storms have been identified and are expected to prove useful in developing and evaluating empirical and physically-based models of extreme rainfall. (Author's abstract)
W90-07579

NUMERICAL SIMULATION OF THE AUGUST 1986 HEAVY RAINFALL EVENT IN THE SYDNEY AREA.
Bureau of Meteorology, Melbourne (Australia). Research Centre.
G. D. Hess.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2073-2082, February 28, 1990. 8 fig, 1 tab, 32 ref.

Descriptors: *Australia, *Cyclonic precipitation, *Meteorology, *Model studies, *Rainfall intensity, *Rainstorms, *Simulation analysis, *Weather forecasting, Convective precipitation, Flooding, Mesoscale numerical model, Numerical analysis, Orographic precipitation.

In the 24-hour period beginning 2300 UTC on August 4, 1986, an intense east coast cyclone produced 328 mm of rain in Sydney, Australia, causing widespread flooding. The operational quantitative precipitation forecast, based on 150-km resolution, was poor, predicting only 16 mm of rain. In this study, numerical simulations of this event are carried out after modifying the large-scale and cumulus convection precipitation mechanisms. These changes make the mechanisms mutually exclusive at a given time and grid point, and more sensitive to orographic forcing and surface energy fluxes. Marked improvement in the amounts of predicted rainfall occurs as the horizontal resolution of the model increases. These results indicate that mesoscale processes play an important role in determining rainfall amounts associated with east coast cyclones and demonstrate the potential to accurately simulate very heavy rainfall events. (Author's abstract)
W90-07580

STATISTICAL MODEL OF EXTREME STORM RAINFALL.
McGill Univ., Montreal (Quebec). Dept. of Physics.
J. A. Smith, and A. F. Karr.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2083-2092, February 28, 1990. 5 fig, 1 tab, 24 ref, append.

Descriptors: *Appalachian Mountains, *Meteorology, *Rainfall intensity, *Rainstorms, *Statistical models, *Storms, *Weather forecasting, Meteorological data collection, Rain gages, Spatial distribution, Temporal distribution, Virginia, West Virginia.

A model of storm rainfall is developed for the central Appalachian region of the United States. The model represents the temporal occurrence of major storms and, for a given storm, the spatial distribution of storm rainfall. The model is used for estimating recurrence intervals of extreme storms. The parameter estimation procedure developed for the model is based on the substitution principle (method of moments) and requires data from a network of rain gages. The model is applied to a 5000 square mile (12,950 square km) region in the Valley and Ridge Province of Virginia and West Virginia. The estimated 100-year storm total ranges from a maximum of 17 inches at the eastern boundary of the region to 6 inches in the western Valley and Ridge. The storm frequency model is used to assess the geomorphic effectiveness of extreme storms in the central Appalachians. The temporal occurrence of extreme storms is modeled by a Poisson process with seasonally varying rate.

The spatial model of storm rainfall is based on a marked point-process representation in which a spatial point process represents locations of storm cells, and the associated marks represent maximum rainfall intensity at the center of a cell. Cell rainfall decays isotropically from the cell center according to a spread function. Spatial inhomogeneities of storm rainfall are explicitly represented. The estimation procedure for the storm field model uses spatially varying estimates of univariate moment functions and an estimator of the stationary spatial correlation function. In parameter estimation, the stationary correlation function depends only on parameters of the spread function. For the case of a quadratic exponential spread function and exponentially distributed cell center rainfall, estimators are obtained for the cell rate of occurrence function $a(x)$, the mean cell center rainfall $b(x)$ per liter, and the cell decay parameter c. The parameter c is estimated by a least squares fit to the estimated spatial correlation function. The functions $a(x)$ and $b(x)$ are estimated from univariate moment equations. If the cell center rainfall distribution has more than one parameter, a corresponding number of univariate moment equations are required. (Chonka-PTT)
W90-07581

PARAMETER ESTIMATION AND SENSITIVITY ANALYSIS FOR THE MODIFIED BARTLETT-LEWIS RECTANGULAR PULSES MODEL OF RAINFALL.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
S. Islam, D. Entekhabi, R. L. Bras, and I. Rodriguez-Iturbe.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2093-2100, February 28, 1990. 16 fig, 4 tab, 7 ref. NSF Grant 8611458-ATM.

Descriptors: *Parameter estimations, *Meteorology, *Rainfall distribution, *Sensitivity analysis, *Model studies, Meteorological data, Spatial distribution, Seasonal distribution, *Rainfall intensity, *Stochastic models, Italy, Arno River Basin, Bartlett-Lewis rectangular pulses model.

The dependence of parameters of a stationary point process model on seasonal and spatial variability of rainfall was investigated. Twenty-four years of hourly rainfall data for two stations from the Arno River basin in central Italy were used to estimate parameters for each month, assuming local stationarity within the month. The estimated model parameters are physically reasonable, vouching for the model's ability to capture the general temporal and spatial structure of rainfall events. Parameter sensitivity analysis provided useful guidelines for understanding the model structure and devising effective parameter estimation strategies. The parameters that control the mean cell duration and its interstorm variance appear to have the most significant influence on the statistical signature of the process. (Chonka-PTT)
W90-07582

ESTIMATION OF MULTIDIMENSIONAL PRECIPITATION PARAMETERS BY AREAL ESTIMATES OF OCEANIC RAINFALL.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
J. B. Valdes, S. Nakamoto, S. S. P. Shen, and G. R. North.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2101-2111, February 28, 1990. 2 fig, 5 tab, 20 ref, append. NASA Grant NAS-5-869.

Descriptors: *Areal precipitation, *Meteorology, *Model studies, *Parameter estimation, *Precipitation intensity, *Precipitation mapping, *Sensitivity analysis, Data interpretation, Estimating models, Global Atlantic Tropical Experiment, Hydrologic models, Marine climates, Meteorological data, Radar, Rain gages, Regression analysis, Satellite technology, Stochastic models.

The parameters of the multidimensional precipitation model proposed by Waymire et al. are estimated using areal-averaged radar measurements of precipitation of the Global Atlantic Tropical Experiment (GATE) data set. The procedure followed was the fitting of the first and second-order moments at different aggregation scales by nonlinear regression techniques. The numerical estimates of the parameters using different subsets of GATE information were reasonably stable, i.e., they were not affected by changes of the area-averaging size, temporal length of the records, and percentage of areal coverage of rainfall. This suggests that the estimation procedure is relatively robust and suitable for estimating the parameters of the multidimensional model in areas of sparse density of rain gages. The use of the space-time spectrum of rainfall may be helpful in the determination of sampling errors due to intermittent visits of future space-borne low attitude sensors of precipitation. (Author's abstract)
W90-07583

TWO-DIMENSIONAL STOCHASTIC-DYNAMICAL QUANTITATIVE PRECIPITATION FORECASTING MODEL.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
T. H. Lee, and K. P. Georgakakos.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2113-2126, February 28, 1990. 9 fig, 24 ref. Department of Interior Grant 14-08-0001-G1297, NSF Grant ECE-8419189, NCSA Grant TRA870098N.

Descriptors: *Hydrologic models, *Meteorological data, *Meteorology, *Precipitation forecasting, *Stochastic models, *Weather forecasting, Areal precipitation, Data interpretation, Estimating equations, Model testing, Rain gages, Statistical models.

A two-dimensional model for quantitative precipitation forecasting at spatial and temporal scales relevant to hydrologic forecasting uses as input operational forecasts of surface air temperature, pressure and dew point temperature, and wind speed and direction at midtropospheric levels. Such forecasts are expected to be available at the spatial scales of the large-scale numerical weather prediction models. The two-dimensional precipitation model produces as an output mean areal precipitation at scales down to 100 square km in space and 1 hour in time. Thermodynamics and microphysics are used to determine the source and sink terms in the conservation equation for the mass of condensed liquid water equivalent used by the model. A state estimator has been designed to update precipitation model states from observations of precipitation in real time and to produce estimates of the variance of the precipitation forecasts. Preliminary tests of the model with hourly data from Oklahoma appear encouraging. The model developed offers a link in the operational environment between the prediction scales of the operational weather prediction models and the hydrologic prediction scales. (Author's abstract)
W90-07584

HYDROLOGIC MODELING OF NEW ENGLAND RIVER BASINS USING RADAR RAINFALL DATA.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
J. Wyss, E. R. Williams, and R. L. Bras.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2143-2152, February 28, 1990. 16 fig, 2 tab, 20 ref. NWS Grant NA80AA-8-00044.

Descriptors: *Flood forecasting, *Flood hydrographs, *Hydrologic models, *Meteorologic data, *Meteorology, *New England, *Radar, *Rainfall-runoff relationships, *River basins, *Streamflow forecasting, Catchment areas, Hydrologic data, Model studies, Streamflow forecasting.

Quantitative weather radar measurements of rainfall provide the input to a hydrologic forecast model designed to use the full spatial resolution of the radar data. The gridded model, which incorporates a detailed map of the stream network, is based on a simple kinematic representation of the river basin response. Only two parameters control the shape of the hydrograph: the velocity characteristic of subsurface flow to the nearest stream, and the streamflow itself. Comparisons are made between model hydrograph forecasts and observed streamflow records for the Souhegan (440 square km) and the Squannacook (160 square km) river basins. A single Z-R relation was used for all storms (Z=230R to the 1.4th power), except for one case with strong convection (Z=400R to the 1.3rd power). A linear scaling of the volume of the radar-derived storm rainfall produces reasonable agreement between the predicted and observed hydrographs. The volume scale factor, which varies from 20 percent or less in the summer to 100 percent in the spring, is consistent with the climatological mean monthly rainfall-runoff ratio. In the two basins studies, for hydrograph peaks of moderate amplitude, overland flow and other quickflow components of the hydrograph are not generally observed. The hillslope response is modeled by a single characteristic subsurface flow velocity (.002 meters per second), with a streamflow velocity of 0.6 meters per second in the Souhegan (0.3 meters per second in the Squannacook). The results suggest that models which utilize the basin geometry and rainfall data to a maximum, but which otherwise contain few parameters, can be successful. (Author's abstract)
W90-07586

ESTIMATION OF CONVECTIVE RAINFALL BY AREA INTEGRALS: 1. THE THEORETICAL AND EMPIRICAL BASIS.
D. Atlas, D. Rosenfeld, and D. A. Short.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2153-2160, February 28, 1990. 2 fig, 1 tab, 31 ref.

Descriptors: *Areal precipitation, *Convective precipitation, *Estimating equations, *Mathematical studies, *Meteorology, *Rainfall rate, *Rainstorms, *Statistical analysis, *Theoretical analysis, Area time integral, Calibrations, Estimating, Instantaneous area-wide rain rate.

This work develops a unified theory for the estimation of both total rainfall from an individual convective storm over its lifetime and the areawide instantaneous rainfall from a multiplicity of such storms by use of measurements of the areal coverage of the storms within a threshold rain intensity isopleth or the equivalent threshold radar reflectivity. The method is based upon the existence of a well-behaved probability density function (pdf) of rain rate either from the many storms at one instant or from a single storm during its life. In the first method, the lifetime storm rainfall volume is $V=((A(tau))T)S(tau)$, where $(A(tau))$ is the average storm area over the life of the storm of duration, T in which R is greater than tau and the bracketed term is the area time integral. In the second method, the instantaneous area rain rate, $(R) = F(tau)S(tau)$, where $F(tau)$ is the fractional observed area with R greater than t. In both methods, $S(tau)$ is the climatological rain rate for the regime divided by the relative frequency with which R is greater than tau. For thresholds exceeding some minimum value, $S(tau)$ is essentially linear with tau for the kind of lognormal pdf which characterizes convective rain, and is constant for specified tau. Thus both the lifetime V of the individual storm and the instantaneous (R) for a multiplicity of storms are linear functions of $A(tau)$ and $F(tau)$, respectively. Because the autocorrelation time of the areawide rain rate of convective storms in areas in access of 10,000 square km is about 5-6 hours, the snapshot (R) is representative of the rain for a few hours. This enhances the accuracy of snapshot measurements for climate purposes and also extends their utility to smaller time/space problems such as hydrology and numerical weather prediction. (See also W90-07588) (Author's abstract)
W90-07587

ESTIMATION OF CONVECTIVE RAINFALL BY AREA INTEGRALS: 2. THE HEIGHT-AREA RAINFALL THRESHOLD (HART) METHOD.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
D. Rosenfeld, D. Atlas, and S. A. Short.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2161-2176, February 28, 1990. 13 fig, 5 tab, 24 ref.

Descriptors: *Areal precipitation, *Convective precipitation, *Estimating, *Height-area rainfall threshold method, *Meteorological data, *Meteorology, *Rainfall intensity, *Rainfall rate, *Statistical analysis, Australia, Clouds, Data interpretation, Error analysis, Infrared imagery, Instantaneous area-wide rain rate, Radar, Remote sensing, South Africa, Texas, Theoretical analysis.

Estimates of instantaneous area average rain rate ((R) in millimeters per hour) are obtained with 5-10 percent accuracy over a large domain simply by measuring (1) the fraction of the area, F(tau), covered by rain intensity greater than a selected threshold tau and (2) the average precipitating cloud top heights. In order to achieve this high accuracy the domain has to be large enough (about 10,000 square km) to include a representative sample of rain cells in different stages of their life cycle, and the measurement of the threshold rain intensity (tau) has to be unbiased. This Height-Area Rainfall Threshold (HART) method was tested with radar data of convective rains from Global Atmospheric Research Program Tropical Atlantic Experiment phase 3, South Africa, west Texas, and a small sample from Darwin, Australia. The results from the locations were found to be consistent and physically plausible. The cloud base temperature seems to play a major role in the determination of the constants of the HART method. The (R)-F(tau) relations were found to be rather insensitive to variations in the Z-R relationships. However, any bias in the measurement of tau causes a similar bias in the derived (R). HART makes possible the accurate estimation of instantaneous rainfall from space when measuring the area and height of the convective rain systems with radar. Passive microwave observations may also be used over the ocean at wavelengths which allow setting a specified rain rate threshold, and when accompanied by infrared measurements of storm top temperatures. Over tropical ocean domains of the order of 10,000 square km and more, the autocorrelation time of about 6 hours permits the area average instantaneous rate to represent the rate for a few hours. (See also W90-07587) (Author's abstract)
W90-07588

RAIN ESTIMATION FROM SATELLITES: EFFECT OF FINITE FIELD OF VIEW.
Applied Research Corp., Landover, MD.
L. S. Chiu, G. R. North, D. A. Short, and A. McConnell.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2177-2185, February 28, 1990. 6 fig, 2 tab, 22 ref, append. NASA Grants NAG-5-869 and NAS5-30083.

Descriptors: *Areal precipitation, *Meteorological data, *Meteorology, *Rainfall rate, *Remote sensing, *Satellite technology, Approximation method, Data interpretation, Estimating, Global Atlantic Tropical Experiment, Model studies, Poisson ratio.

Nonuniform rain rates within a field of view (FOV) and a nonlinear rain rate-microwave temperature (R-T) relation lead to a bias in the estimation of areal average rain rate from spaceborne microwave measurements. This bias was estimated from rain rate data collected during the Global Atmospheric Research Program Atlantic Tropical Experiment (GATE) using a R-T relation which is derived from model results. The bias is about 25 percent (30 percent) for a footprint size of 8 km and increases to about 40 percent (45 percent) for a footprint size of 40 km for phase I (II) of GATE. In the large FOV limit of 280 km footprint size, the bias is 48 percent (50 percent). An experiment was performed in which the biases calculated from phase I were applied to phase II for different rain rate categories. The empirical correction works quite well. An approximate formula which takes account of the effect of spatial inhomogeneity within the FOV and a nonlinear R-T relations is

derived. The bias formula is applied to rain field models. For a rain field model where the autocorrelation function is defined by an exponential, the dependence of the bias on the ratio of the FOV size and the e-folding scale is very similar to those calculated from the GATE data. For a Poisson process rain field model the bias formula shows an inverse dependence on the probability of rain. In this context, the lower percent bias for phase I of GATE can be understood in terms of the higher probability of rain during the same period. (Author's abstract)
W90-07589

BEAM FILLING ERROR IN THE NIMBUS 5 ELECTRONICALLY SCANNING MICROWAVE RADIOMETER OBSERVATIONS OF GLOBAL ATLANTIC TROPICAL EXPERIMENT RAINFALL.
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
D. A. Short, and G. R. North.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2187-2193, February 28, 1990. 8 fig, 20 ref.

Descriptors: *Error analysis, *Global Atlantic Tropical Experiment, *Measuring instruments, *Meteorology, *Radiometry, *Rainfall rate, *Remote sensing, Comparison studies, Microwaves, Statistical models.

A comparison of rain rates retrieved from the Nimbus 5 electronically scanning microwave radiometer (ESMR 5) brightness temperatures and observed from shipboard radars during the Global Atlantic Tropical Experiment (GATE) phase I shows that the beam filling error is the major source of discrepancy between the two. When averaged over a large scale (the GATE radar array, 400 km in diameter), the beam filling error is quite stable, being 50 percent of the observed rain rate. This suggests the simple procedure of multiplying retrieved rain rates by 2 (correction factor). A statistical model of the beam filling error is developed by envisioning an idealized instrument field-of-view that encompasses an entire gamma distribution of rain rates. A modeled correction factor near 2 is found for rain rate and temperature characteristics consistent with GATE conditions. The statistical model also suggests that (1) the correction factor varies from 1.5 to 2.5 for suppressed to enhanced tropical convective regimes and (2) decreases to 1.5 as the freezing level and average depth of the rain column decreases to 2.5 km. (Author's abstract)
W90-07590

SAMPLING ERRORS FOR SATELLITE-DERIVED TROPICAL RAINFALL: MONTE CARLO STUDY USING A SPACE-TIME STOCHASTIC MODEL.
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
T. L. Bell, A. Abdullah, R. L. Martin, and G. R. North.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2195-2205, February 28, 1990. 9 fig, 1 tab, 15 ref.

Descriptors: *Areal precipitation, *Error analysis, *Meteorology, *Monte Carlo method, *Satellite technology, *Stochastic models, *Tropical regions, Global Atlantic Tropical Experiment, Rainfall rate, Sampling, Simulation analysis.

Estimates of monthly average rainfall based on satellite observations from a low Earth orbit will differ from the true monthly average because the satellite observes a given area only intermittently. This sampling error inherent in satellite monitoring of rainfall would occur even if the satellite instruments could measure rainfall perfectly. The size of this error for a satellite system being studied at NASA, the Tropical Rainfall Measuring Mission (TRMM) is estimated. The statistical description of rainfall on scales from 1 to 1000 km, based on rainfall data from the Global Atmospheric Research Project Atlantic Tropical Experiment (GATE), is examined in detail. A TRMM-like satellite is flown over a two-dimensional time-

evolving simulation of rainfall using a stochastic model with statistics tuned to agree with GATE statistics. The distribution of sampling errors found from many months of simulated observations is found to be nearly normal, even though the distribution of area-averaged rainfall is far from normal. For a range of orbits likely to be employed by TRMM, sampling error is found to be less than 10 percent of the mean for rainfall averaged over a 500 x 500 square km area. (Author's abstract)
W90-07591

VARIABILITY OF SUMMER FLORIDA RAINFALL AND ITS SIGNIFICANCE FOR THE ESTIMATION OF RAINFALL BY GAGES, RADAR, AND SATELLITE.
McGill Weather Radar Observatory, Ste. Anne de Bellevue (Quebec).
A. Seed, and G. L. Austin.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2207-2215, February 28, 1990. 10 fig, 4 tab, 14 ref, append.

Descriptors: *Florida, *Meteorology, *Radar, *Rain gages, *Rainfall rate, *Remote sensing, *Simulation analysis, *Weather satellites, Convective precipitation, Error analysis, Estimating, Precision, Seasonal distribution, Spatial distribution, Statistical analysis, Variability.

Simulations based on a month of radar data from the Patrick Air Force Base radar in Florida give the following results for the estimation of daily rainfall amounts over the 124,000 square km area covered by the radar: (1)30 minute sampling by a perfect satellite sensor will increase the rainfall measurement error by 7 percent compared with 5 minute radar sampling, (2)if the instrument is only able to determine the raining area and a good climatological rainfall rate is available, then the measurement error is increased to 35 percent, and (3) exceptionally dense gage networks are needed to estimate daily convective rainfall (for example, a network with 625 square km per gage would be required to equal a minute rain-area-only technique). For monthly areal mean rainfall, the proposed Tropical Rain Measuring Mission (TRMM) sampling strategy with a perfect satellite sensor gives errors of the order of 22 percent. A 30 minute rain-area-only technique combined with a good climatological rainfall rate yields an error of at least 32 percent. The main contribution of TRMM could be to provide good estimates of the mean climatological rainfall rate (given that it is raining), which could then be used with the geostationary weather satellite to provide the required monthly area rainfall estimates. (Author's abstract)
W90-07592

ESTIMATING THE EXCEEDANCE PROBABILITY OF RAIN RATE BY LOGISTIC REGRESSION.
Applied Research Corp., Landover, MD.
L. S. Chiu, and B. Kedem.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2217-2227, February 28, 1990. 1 fig, 15 tab, 27 ref, append. NASA Grant NAS5-30083.

Descriptors: *Meteorology, *Rainfall intensity, *Rainfall rate, *Regression analysis, Data interpretation, Estimating equations, Global Atlantic Tropical Experiment, Logistic regression, Radiometry, Simulation analysis.

Recent studies have shown that the fraction of an area with rain intensity above a fixed threshold is highly correlated with the area-averaged rain rate. To estimate the fractional rainy area, a logistic regression model, which estimates the conditional probability that the rain rate over an area exceeds a fixed threshold given the values of related covariants, is developed. The problem of dependency in the data in the estimation procedure is bypassed by the method of partial likelihood. Analyses of simulated scanning multichannel microwave radiometer and observed electrically-scanning microwave radiometer data during the Global Atlantic Tropical Experiment (GATE) period show that the use of logistic regression in pixel classification is superior to multiple regression in predicting whether rain

rate at each pixel exceeds a given threshold. Application of these regression techniques to simulated scanning multichannel microwave radiometry (SMMR) and the actual electrically scanning microwave radiometry (ESMR 5) data during the GATE period indicates that accurate covariate information consisting of microwave brightness temperatures at various frequencies can lead to precise prediction of exceedance. The logistic regression model is also applicable for noisy covariants provided that the noise level is not very high. Fluctuations in meteorological parameters are of the order of a few degrees Kelvin. Hence, variabilities of meteorological parameters must be accounted for if the logistic regression is to be applied to estimate rain rate space. (Author's abstract)
W90-07593

EXTREME RAINFALL IN CALDERDALE, 19 MAY 1989.
Institute of Hydrology, Wallingford (England).
M. Acreman.
Weather WTHRAL, Vol. 44, No. 11, p 438-446, November 1989. 5 fig, 14 ref.

Descriptors: *England, *Excess rainfall, *Meteorology, *Rainfall intensity, *Rainstorms, Flood damage, Flood flow, Flood profiles, Historic floods, Meteorological data collection, Rainfall index, Reservoirs, Stream discharge.

The rainfall event of 19 May 1989 in West Yorkshire, England, was clearly extreme. Very intense rainfall is required to trigger the landslips, river bank erosion and widespread flooding which resulted. There are no means by which the peak rainfall intensity can be calculated retrospectively; estimates from weather radar, while giving a good indication of timing and the spatial extent of storms, often produce only a poor indication of rainfall amounts. Other indirect evidence, from river flows, reservoir levels and geomorphological response, provide only rough guesses. The only raingage at the center of the storm measured in excess of 193 mm, which probably fell in about two hours. While there is no specific evidence to disprove this rainfall total, many meteorologists are convinced only by a level of corroboration which, for this event, is not available. (Author's abstract)
W90-07596

REGIONAL ANALYSES OF PRECIPITATION ANNUAL MAXIMA IN WASHINGTON STATE.
Washington State Dept. of Ecology, Olympia. Dam Safety Section.
M. G. Schaefer.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 119-131, January 1990. 8 fig, 7 tab, 24 ref.

Descriptors: *Climatology, *Data analysis, *Meteorology, *Precipitation, *Precipitation rate, *Regional analysis, *Washington, Annual precipitation, Areal precipitation, Statistical analysis.

In 1981 the Dam Safety Section of the Department of Ecology embarked upon a program to develop frequency based criteria for computing inflow design floods for dams in the state of Washington. Regional analyses of precipitation data were conducted using an index flood type methodology and probability weighted moments parameter estimates for the generalized extreme value distribution. Annual maximum series data were collected at 115 stations for durations of 2 and 6 hours and at 315 stations for the 24-hour duration. Because the climate in Washington varies from arid to rain forest, the issues of homogeneity and region definition posed major problems. Those problems were circumvented by considering the state to be a heterogeneous superregion. Climatologically homogeneous subregions within the superregion were defined in terms of mean annual precipitation (MAP) rather than geographic location. The subregional values of the coefficients of variation Cv and skew, gamma were found to vary systematically with MAP across the superregion. This allowed the superregional values of Cv and gamma to be expressed as continuous variables instead of conven-

tional fixed values and eliminated the boundary problems normally associated with subregion definition. Smaller values of Cv, and gamma were associated with humid and rain forest environments. All subregional solutions were within, or near, the extreme value type II family. (Author's abstract)
W90-07644

TOPOGRAPHIC DISTRIBUTION OF CLEAR-SKY RADIATION OVER THE KONZA PRAIRIE, KANSAS.
California Univ., Santa Barbara. Dept. of Geography.
R. Dubayah, J. Dozier, and F. W. Davis.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 679-690, April 1990. 7 fig, 3 tab, 26 ref. NASA Grant NAG 5-917.

Descriptors: *Model studies, *Prairies, *Solar radiation, Albedo, Clear-sky radiation, Optical depth, Sun angle, Terrain slope.

Concern over increasing human impacts on regional and global climate has focused attention on the use of satellite data for obtaining measurements of surface parameters, such as evapotranspiration and soil moisture, as inputs to regional and global climate models. Incoming solar radiation is a key fator in most surface climate processes. The topographic distribution of clear-sky incoming solar radiation was analyzed over the tallgrass Konza Prairie, site of FIFE, the First ISLSCP (International Satellite Land Surface Climatology Program) Field Experiment. Using a two-stream atmospheric radiation model and digital elevation grids of 25-, 50-, and 100-m grid spacing, clear-sky radiation was simulated throughout the day for three dates: December 15, March 15, and June 15. Geostatistical analysis was used to characterize the spatial and temporal variability in modeled radiation at each grid spacing. The variance and spatial autocorrelation of simulated incoming radiation depends on Sun angle and elevation grid spacing. The behavior of the variance as a function of Sun angle, optical depth, and mean terrain slope can be explained by considering direct radiation variability on a simplified terrain model of uniform albedo where slopes are equal and azimuths are distributed uniformly in all directions. For this constant-slope model it can be shown analytically that the solar zenith angle at which variance is maximized is a function of optical depth only and is independent of elevation, slope, and aspect. Results from the two-stream simulations support this conclusion and suggest its applicability to real terrain. (Author's abstract)
W90-07676

SULFUR, NITROGEN, AND PH LEVELS IN WISCONSIN PRECIPITATION.
Wisconsin Univ., Madison. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W90-07700

HEAVY RAINFALL AT KHARTOUM ON 4-5 AUGUST 1988: A CASE STUDY.
Sudan Meteorological Dept., Khartoum (Sudan).
A. M. A. Ali.
Meteorological Magazine MTMGA5, Vol. 118, No. 1408, p 229-235, November 1989. 10 fig, 1 ref.

Descriptors: *Air masses, *Excess rainfall, *Meteorology, *Rainstorms, *Sudan, Atmospheric circulation, Cloudbursts, Data interpretation, Moisture, Rainfall distribution, Squalls, Wind.

The intertropical convergence zone (ITCZ) is a narrow region where northerly and southerly tropospheric winds meet. It shows a discontinuity of moisture which in the Sudan is usually indicated at the surface by the location of the 15 C dew-point isopleth. On August 4, heavy rainfall was registered in north Sudan at Atbara (64 mm) and especially Khartoum (210 mm). At Khartoum the rain fell in two storms, on August 4 and 5. Meteorological factors involved in this rare event were examined using all surface and upper-air data available. Rainfall was due to several factors, including: the ITCZ had moved to an advanced northerly posi-

tion on August 4; a deep vortex developed to the north of Khartoum as a result of intense surface heating coupled with an approaching trough at upper levels; there was a deep layer of vertical motion over the Khartoum area leading to the formation of massive cumulonimbus clouds; and moisture injection into the area. Moisture came from widespread rainfall to the south and southwest on August 3 combined with a deep layer of strong southwesterly winds which continued until August 4, and from the arrival of a line squall from the east into the area 2 hours before 0000 UTC on August 5. The joint effect of the line squall and the local development of clouds which acted as a feeding mechanism to the squall, were the main causes of the second storm. (VerNooy-PTT)
W90-07710

CHARACTERISTICS OF CUMULUS BAND CLOUDS OFF THE COAST OF HAWAII.
Washington Univ., Seattle. Dept. of Atmospheric Sciences.
G. B. Raga, J. B. Jensen, and M. B. Baker.
Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 3, p 338-355, February 1990. 16 fig, 43 ref. NSF grant ATM 8420816.

Descriptors: *Cloud physics, *Clouds, *Hawaii, *Meteorology, *Remote sensing, *Weather, Cloud bands, Convection, Convergence, Data acquisition, Data interpretation, Entrainment, Inversions, Model studies, Thermodynamics, Tradewinds.

Aircraft observations from seventeen cumulus cells within cloud bands observed off the east coast of Hawaii during the Joint Hawaii Warm Rain Project (JHWRP) of 1985 were analyzed. Low level convergence generated by the encounter of the tradewinds and the island determines the location of the initial convection. However, the upward momentum below cloud base seems to be less important in the subsequent evolution of the bands than buoyancy associated with latent heat release. Entrainment into the clouds occurs at all levels, and almost all cloudy parcels below the trade inversion are moving upwards. While evaporative cooling does not seem to enhance entrainment below the inversion, it does play a role in the descent of cloud top air to the bottom of the inversion. Despite the existence of undiluted cores, the average thermodynamic characteristics of the clouds below the inversion appear well described by a very simple, constant lateral entrainment rate parcel model. In-cloud and near environment vertical fluxes of mass, water, heat, and horizontal momentum were used to estimate the band cloud impacts on vertical profiles of these tracers in the cloud and above cloud layers. Results from three-dimensional simulations of the Hawaiian bands show that the flow in the along-band direction is strongest between the surface and 250 m, well below cloud base. Within the cloud layer, the flow is basically across the bands. Thus the along-band contribution is not expected to be significant compared to the outflow in the plane perpendicular to the bands. (Author's abstract)
W90-07735

ESTIMATION OF MEAN RAIN RATE: APPLICATION TO SATELLITE OBSERVATIONS.
Maryland Univ., College Park. Dept. of Mathematics.
For primary bibliographic entry see Field 7B.
W90-07825

SHORT-DURATION RAINFALLS IN ITALY.
Palermo Univ. (Italy). Ist. di Idraulica.
G. B. Ferreri, and V. Ferro.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 430-435, March 1990. 2 fig, 1 tab, 9 ref, append.

Descriptors: *Drainage systems, *Italy, *Mathematical models, *Model studies, *Rainfall, Rain gages, Sardinia, Sicily.

Drainage system design is generally based on knowledge of short-duration rainfall with a fixed return period. Using selected Sicilian short-duration rainfall data, the authors test the independence

of short-duration rainfalls and geographical factors was tested. The applicability of Bell's rainfall-duration relationship in Sicily and Sardinia was verified. For each island, an exponential relationship was proposed between the mean value of the ratio of the t-min rainfall to the 60-minute rainfall sample and the duration t. These relationships give values approximately equal to those calculated by Bell's relationship, and seem to confirm the independence of short duration rainfall depth-duration relationships from geographic factors. (Author's abstract)
W90-07834

TIME-MEAN PRECIPITATION AND VERTICAL MOTION PATTERNS OVER THE UNITED STATES.
Maryland Univ., College Park. Cooperative Inst. for Climate Studies.
H. M. Van den Dool.
Tellus TELLAL, Vol. 42A, No. 1, p 51-64, January 1990. 4 fig, 6 tab, 21 ref, append.

Descriptors: *Flow equations, *Mathematical models, *Meteorology, *Precipitation, *Rainfall distribution, *Vertical flow, *Weather patterns, Climatic data, Maps, Mean flow vorticity fluxes, Statistical analysis, Transient eddy vorticity fluxes.

A post-initialize set of global atmospheric gridded data, generated at the National Meteorological Center, is used to calculated monthly mean vertical motion at 500 millibars (mb) for all months in 1984-1986. Various methods, such as those based on the continuity (the best and easiest) and vorticity equations are used to calculate monthly mean vertical motion (mmvm). The mmvm fields are correlated with colocated monthly precipitation collected in raingauges and averaged over Climate Divisions in the United States. The correlation for the United States as a whole is negative, the coefficient ranging from about -0.6 in winter to small negative values in summer. Statistical significance is reached in 10 out of 12 months. The vorticity equation is used to decompose mmvm into contributions from mean flow and transient eddy vorticity fluxes, respectively. The transient eddy fluxes are smaller by a factor of two and nearly opposite to the mean flow fluxes, and seem to force vertical motions that are roughly out of phase with the precipitation field. Using mean flow fluxes only and accepting geostrophic constraints, the results deteriorate. The above results are true for 3-year monthly means, as well as for departures from climatology (anomalies). Statistics for the 3-year period, and some examples in map-form are presented. (Author's abstract)
W90-07948

RAINFALL AND SALINITY OF A SAHELIAN ESTUARY BETWEEN 1927 AND 1987.
Centre de Recherches Oceanographiques de Dakar-Thiaroye (Senegal).
For primary bibliographic entry see Field 2L.
W90-07993

STORM-RUNOFF GENERATION IN THE PERMANENTE CREEK DRAINAGE BASIN, WEST CENTRAL CALIFORNIA--AN EXAMPLE OF FLOOD-WAVE EFFECTS ON RUNOFF COMPOSITION.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2E.
W90-07994

EFFECT OF TROPICAL ATLANTIC ANOMALIES UPON GCM RAIN FORECASTS OVER THE AMERICAS.
Universidade Federal do Rio de Janeiro (Brazil). Dept. of Meteorology.
J. Buchmann, J. Paegle, L. E. Buja, and R. E. Dickinson.
Journal of Climate JLCLEL, Vol. 3, No. 2, p 189-208, February 1990. 17 fig, 14 ref. NSF grants INT 8602690, ATM 8611951, and ATM 8905369.

Descriptors: *Climatology, *Model studies, *Precipitation, *Tropic zone, *Weather forecasting,

Group 2B—Precipitation

*Weather patterns, Atlantic Ocean, Atmospheric circulation, Drought, General Circulation model, Heating anomalies, Meteorological data, North America, South America, Water temperature.

Severe droughts over easter sections of North America and central sections of South America in 1986 and 1988 were characterized by above-normal tropical Atlantic sea surface temperatures and convection. The response of a general circulation model to positive heating anomalies in the tropical Atlantic sector was investigated. An 8-case control ensemble of 30 day global predictions was made starting from the atmospheric state observed on January 1 of each year from 1977-84. These 8 cases were integrated in an experimental ensemble that was identical to the first control ensemble, except that a heating term was added to the thermodynamic equation in a region centered at 30 degrees W, 6.6 degrees N, in order to simulate the latent heating of enhanced tropical Atlantic convection. In the third ensemble the heating was centered at 6.6 S. Both heated ensembles produced reductions of forecast precipitation over most of North and South America. The greatest precipitation reductions were forecast over the southern and eastern U.S. The South American response was more sensitive to the placement of the heating anomaly. When the anomaly was located north of the equator, drying occurred over northeast Brazil; this region received increased rainfall when the anomaly was located south of the equator. Both experiment ensembles displayed a region of reduced rainfall over the Andes Mountains and southern portions of Brazil. Usage of real initial data and an ensemble of cases permits one to draw quantitatively meaningful estimates of the time scale of response and case-to-case variability. For the tested cases, the South American response was evident by day 5, but exhibited substantial intersample variability. The model drying effects can be explained only partly by enhanced local subsidence; much of the rainfall reduction appears to be related to a reorientation of the synoptic scale wave pattern in which the lower tropospheric circulation is unfavorable for water vapor inflow from source regions over the tropical Atlantic and Amazon Basin. (Author's abstract)
W90-08003

PRECIPITATION CLIMATOLOGY OF 5-DAY PERIODS.
National Meteorological Center, Washington, DC. Climate Analysis Center.
E. S. Epstein, and A. G. Barnston.
Journal of Climate JLCLEL, Vol. 3, No. 2, p 218-236, February 1990. 23 fig, 9 ref.

Descriptors: *Climatology, *Precipitation, *Rainfall distribution, *Weather forecasting, Data interpretation, Graphical analysis, Markov chain model, Meteorological data.

A precipitation climatology was developed for the relative frequencies of zero, one, or two or more days with measurable precipitation within 5-day periods. In addition, the distribution of precipitation amounts is given for the one wet day in five and for the more than one wet day in five categories. The purpose of the climatology is to provide background for the development and introduction of extended-range (6-10 day forecast period) precipitation forecasts in terms of the probabilities of the three categories. The climatology is based on 36 years of precipitation data at 146 stations in the contiguous U.S. Details of the treatment of the data are provided. Diagrams are developed to display the seasonal patterns of frequency and amount for individual stations. The frequency diagram is a nomogram based on a simple Markov chain model for precipitation occurrences. It can be used to infer--from the frequencies of 0 and exactly 1 wet day in 5--single-day climatological precipitation probabilities or the probabilities conditional on precipitation falling on the previous day (or to infer-- from the daily climatology and knowledge of the persistence--the probability of the three categories of the 5-day period). These diagrams are useful for describing and comparing precipitation climatologies and should aid the forecaster in making and interpreting probability forecasts of precipitation frequency for the 6-10 day period, where day-by-day forecasts are unfeasible. (Author's abstract)

W90-08004

VARIATION IN UNITED STATES CLOUDINESS AND SUNSHINE DURATION BETWEEN 1950 AND THE DROUGHT YEAR OF 1988.
National Oceanic and Atmospheric Administration, Silver Spring, MD. Air Resources Lab.
J. K. Angell.
Journal of Climate JLCLEL, Vol. 3, No. 2, p 296-308, February 1990. 11 fig, 4 tab, 29 ref.

Descriptors: *Climatology, *Cloud cover, *Drought, *Meteorology, *Sunshine duration, *Weather patterns, Correlation analysis, El Nino/ Southern Oscillation, Precipitation, Seasonal variation.

The variations in United States cloudiness and sunshine duration are examined for the years 1950-88. During this period, the correlation between annual values of cloudiness and sunshine duration within the contiguous U.S. was -0.86, significant at the 1% level. The years of maximum cloudiness and minimum sunshine duration were 1972 and 1982, when strong El Ninos began. The year of maximum sunshine duration was 1988, but the years of minimum cloudiness were 1952-56 (mini dust bowl); the discrepancy is a result of the greater long-term increase in cloudiness than decrease in sunshine duration. In the spring of 1988 there were anomalous values of cloudiness (below average) and sunshine duration (above average) in north central, south central and southeast regions of the U.S., the deviations from average approaching 10%. In the summer of 1988 these deviations were anomalous only in north central and northwest regions. Despite the low value of cloudiness in 1988, based on this analysis the cloudiness increased by 2.0 +/-1.3% between 1950-68 and 1970-88 (corresponding to a percentage increase of 3.5% since the average cloudiness was 58%, during 1950-88). The increase in cloudiness was close to 2% in all 6 regions of the country, and significant at the 5% level in all regions except the southeast. Most of the increase in cloudiness was in autumn, with a negligible increase in spring. The decrease in U.S. sunshine duration between 1950-68 and 1970-88, however, is only -0.8 +/-1.2% (corresponding to a percentage decrease of -1.2% since the average sunshine duration was 63% during 1950-88). The difference between cloudiness increase, and sunshine duration decrease is most apparent in the west and may be due in part to an increase in cirrus not thick enough to turn off the sunshine recorder. There has been a correlation of 0.79 (significant at the 1% level) between annual cloudiness and precipitation within the U.S. during 1950-88, but the correlation of -0.43 between annual cloudiness and surface temperature (above-average cloudiness associated with below-average temperature) is not quite significant at the 5% level. There is a possible relation between the 1987 El Nino and U.S. cloudiness and sunshine duration. (Author's abstract)
W90-08006

ANALYSIS OF THE THRESHOLD METHOD FOR MEASURING AREA-AVERAGE RAINFALL.
Maryland Univ., College Park. Dept. of Mathematics.
B. Kedem, L. S. Chiu, and Z. Karni.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 1, p 3-20, January 1990. 12 fig, 5 tab, 10 ref.

Descriptors: *Areal precipitation, *Rainfall area, *Rainfall distribution, *Rainfall rate, *Statistical analysis, Satellite technology.

Experimental evidence shows that the area-average rain rate and the fractional area covered by rain rate exceeding a fixed threshold are highly correlated; that is, are highly linearly related. A precise theoretical explanation of this fact is based on the observation that rain rate has a mixed distribution, one that is a mixture of a discrete distribution and a continuous distribution. Under a homogeneity assumption, the slope of the linear relationship depends only on the continuous part of the distribution and as such is found to be markedly immune to parameter changes. This is

illustrated by certain slope surfaces obtained from three specific distributions: the lognormal, gamma, and inverse Gaussian distributions. The densities of these distributions display different tail behavior and thus cover a fairly wide range of phenomena. Also, these three distributions are convenient choices because they can be reparameterized in terms of the mean and variance only. This fact allows for comparison across distributions by referring to the mean and variance and avoiding direct reference to particular distribution parameters. The threshold level can be chosen in an optimal way by minimizing a certain distance function defined over the threshold range. In general, the threshold level should not be too far from the mean rain rate conditional on rain. The so-called 'threshold method' advocates measuring rainfall from fractional area exploiting the observed linear relationship of the fractional area with the area average rain rate. The method is potentially useful for the estimation of rainfall from space via satellites. (Fish-PTT)
W90-08197

ECONOMIC EFFECTS OF PRECIPITATION ENHANCEMENT IN THE CORN BELT.
Illinois State Water Survey Div., Champaign. Climate and Meteorology Section.
For primary bibliographic entry see Field 3B.
W90-08198

STUDIES OF PRECIPITATION PROCESSES IN THE TROPOSPHERE USING AN FM-CW RADAR.
Technische Hogeschool Delft (Netherlands). Faculty of Electrical Engineering, Telecommunication and Remote Sensing Technology.
L. P. Ligthart, and L. R. Nieuwkerk.
Journal of Atmospheric and Oceanic Technology JAOTES, Vol. 6, No. 5, p 798-808, October 1989. 14 fig, 1 tab, 13 ref.

Descriptors: *Atmospheric water, *Precipitation, *Radar, *Rainfall disposition, *Rainfall distribution, Fluid drops, Hydrometeorology, Polarization.

Radar probing of the troposphere has, for decades, been an important tool in the measurement of atmospheric phenomena. In the field of FM-CW tropospheric radar, new breakthroughs have become possible due to progress in FM-CW radar hardware, in FM-CW radar signal processing and in the availability of the Doppler polarimetric FM-CW radar DARR. DARR has a high resolution in range, Doppler, and polarization. Doppler resolution of a few centimeters per second combined with a maximum Doppler range of +/-9 meters per second can be obtained. Two mechanical polarizers, located directly behind the center feeds of the transmit and receive antenna, were employed, operating over polarization angles of plus or minus 90 degrees. Doppler and polarimetric reflectivity profiles were measured. The melting process during stratiform rain and raindrop size distribution have been modeled and verified, based on these profiles. The sensitivity with high resolution in range, in Doppler, and in scattering matrix characterization indicates that this radar can be applied to verify and evaluate new models for the melting layer and for the drop size distribution of different types of hydrometeors. (Fish-PTT)
W90-08199

SOURCES OF SAHEL PRECIPITATION FOR SIMULATED DROUGHT AND RAINY SEASONS.
National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies.
L. M. Druyan, and R. D. Koster.
Journal of Climate JLCLEL, Vol. 2, No. 12, p 1438-1446, December 1989. 11 fig, 1 tab, 13 ref.

Descriptors: *Africa, *Climatic data, *Deserts, *Model studies, *Precipitation, *Precipitation mapping, *Sahel, Advection, Continental hydrology, Drought, Evaporation, Marine climates, Moisture availability, Rainfall simulation, Water vapor.

The sources of sub-Saharan precipitation were studied using diagnostic procedures integrated into the code of the Goddard Institute for Space Studies climate model. Water vapor evaporating from defined source regions was 'tagged,' allowing the determination of the relative contributions of each evaporative source to the simulated July rainfall in the Sahel. Two June-July simulations were studied to compare the moisture sources, moisture convergence patterns and the spatial variations of precipitation for rainy and drought conditions. Results for this case study indicate that patterns of moisture convergence and divergence over Africa had a stronger influence on model rainfall over the sub-Sahara than did evaporation rates over the adjacent oceans or moisture advection from ocean to continent. While local continental evaporation contributed significant amounts of water to Sahelian precipitation in the 'rainy' simulation, moisture from the Indian Ocean did not precipitate over the Sahel in either case. (Author's abstract)
W90-08200

HARMONIC ANALYSIS OF THE SEASONAL CYCLE IN PRECIPITATION OVER THE UNITED STATES: A COMPARISON BETWEEN OBSERVATIONS AND A GENERAL CIRCULATION MODEL.
State Univ. of New York at Stony Brook. Inst. for Atmospheric Sciences.
K. I. Kirkyla, and S. Hameed.
Journal of Climate JLCLEL, Vol. 2, No. 12, p 1463-1475, December 1989. 13 fig, 10 ref.

Descriptors: *Frequency analysis, *Hydrologic models, *Precipitation, *Seasonal variation, Atmospheric circulation, Climatology, Comparison studies, Model studies, Rainfall area, United States.

Harmonic analysis has been employed to study the seasonal variation of precipitation over the conterminous United States, using precipitation values obtained from a version of the Oregon State University general circulation model and observational gridded data. Maps of the first, second, and third harmonic amplitudes and phases provide a useful source of comparison between model output and observational data. Results indicate that the method of harmonic analysis allows a more analytical comparison between model predictions and data than the conventional approach of representing the annual march in the form of a curve of mean monthly rainfall amounts. The method delineates regional boundaries of the various precipitation regimes in the United States. The general circulation model captures a significant amount of the regional detail in precipitation climatology when its results are decomposed by harmonic analysis. (Author's abstract)
W90-08201

STORM RUNOFF SIMULATION USING AN ANTECEDENT PRECIPITATION INDEX (API) MODEL.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
For primary bibliographic entry see Field 2E.
W90-08221

DETAILED DELIMITATION OF RAINFALL REGIONS IN SOUTHERN AFRICA.
Natal Univ., Pietermaritzburg (South Africa). Dept. of Agricultural Engineering.
M. C. Dent, S. D. Lynch, and H. Tarboton.
Water SA WASADV, Vol. 16, No. 1, p 1-4, January 1990. 3 fig, 16 ref.

Descriptors: *Climatic data, *Climatology, *Digital map data, *Hydrological regime, *Precipitation, *Precipitation mapping, *Rainfall area, *South Africa, Agricultural engineering, Agricultural watersheds, Altitude, Boundary conditions, Computers, Continental hydrology, Rainfall distribution, Topography.

The concept of a homogeneous rainfall region is particularly useful for hydrological studies in the fields of agriculture and engineering. With the enhancement of computer power, digitizers, and enlarged data sets, the delimitation of rainfall regions in South Africa has become both desirable and possible with greater detail and accuracy than previously. In a recent study, 712 homogeneous rainfall regions were delimited according to the following criteria: mean annual precipitation (MAP); altitude; aspect; topographic complexity; and agricultural population distribution. A data base of altitude points spaced at one minute of a degree and over 5,000 rainfall stations with more than 10 years of record was used. A digital, classified image of altitude upon which was superimposed the MAP at each station, provided the basis for a careful manual pattern recognition exercise to delimit the rainfall regions. The boundary points of the 712 regions have been digitized and are stored in coordinates of latitude and longitude. It is therefore possible to plot maps of any scale and projection. The results of this comprehensive study are already proving valuable in a wide range of applications. (Author's abstract)
W90-08226

THUNDERSTORM CLIMATOLOGICAL RESEARCH IN GREAT BRITAIN AND IRELAND: A PROGRESS REPORT AND AIMS FOR FUTURE STUDY.
Tornado and Storm Research Organisation, Corsham (England). Thunderstorm Div.
K. O. Mortimore.
Weather WTHRAL, Vol. 45, No. 1, p 21-27, January 1990. 3 fig, 14 ref.

Descriptors: *Climatology, *England, *Ireland, *Meteorological data collection, *Meteorology, *Scotland, *Thunderstorms, *Wales, Electric power production, Foreign research, Geographic information systems, Information exchange, Insurance, Lightning, Marine climates, Networks, Research priorities, Risks, Statistics, Synoptic analysis.

Thunderstorm research in Great Britain and Ireland has progressed from a few limited studies during the latter half of the 19th century to the long-running investigations carried out by the Thunderstorm Census Organisation from 1924 to 1982, by the Electrical Research Association from 1948 to 1974, and more recently by the Thunderstorm Division of the Tornado and Storm Research Organisation. A thunderstorm research organization must operate through a close network of voluntary observers in all parts of the area under investigation; maintaining a large network is not without problems of recruitment and of funding. The climatological definition, 'Days with thunder heard,' is subject to a great deal of ambiguity and observational error. To provide a more comparable climatological statistic and to improve our knowledge of the geographical distribution of thunderstorms it is recommended that a new criteria be adopted: 'Days with close thunder.' Five kilometers is proposed as representative of 'close' thunderstorm. On average, thunder is most likely to occur at inland locations furthest downwind from maritime influences, in areas of greatest insulation. Further research is required in thunderstorm distribution with respect to the synoptic patterns providing the conditions suitable for storm development. The electricity supply authorities, the electronics industry and insurance companies are a selection of bodies with a particular interest in knowing which areas are most at risk to lightning damage so it is very important that such information be available in great depth for all regions. (Fish-PTT)
W90-08235

SIMPLE STOCHASTIC MODEL OF HOURLY RAINFALL FOR FARNBOROUGH, ENGLAND.
Institute of Hydrology, Wallingford (England).
M. C. Acreman.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 2, p 119-148, April 1990. 16 fig, 13 tab, 24 ref.

Descriptors: *England, *Meteorology, *Model studies, *Rainfall rate, *Stochastic models, Data interpretation, Profiles, Seasonal variation.

A stochastic rainfall model which has been developed to generate synthetic sequences of hourly rainfalls at a point was described. The model has been calibrated using data from Farnborough in Hampshire, England. This rainfall data series was divided into wet and dry spells; analysis of the durations of these spells suggests that they may be represented by exponential and generalized Pareto distributions respectively. The total volume of rainfall in wet spells was adequately fitted by a conditional gamma distribution. Random sampling from a beta distribution, defining the average shape of all rainfall profiles, is used in the model to obtain the rainfall profile for a given wet spell. Results obtained from the model compare favorably with observed monthly and annual rainfall totals and with annual maximum frequency distributions of 1, 2, 6, 12, 24 and 48 hours duration at Farnborough. The model has a total of 22 parameters, some of which are specific to winter or summer seasons. (Author's abstract)
W90-08266

GEOMORPHOLOGIC RAINFALL-RUNOFF MODEL: INCORPORATING PHILIP'S INFILTRATION EXPRESSION.
Cairo Univ., Giza (Egypt). Dept. of Irrigation and Hydraulics.
M. N. Allam.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 262-281, March/April 1990. 5 fig, 6 tab, 19 ref. King Abdulaziz City for Science and Technology Grant AR-07-85.

Descriptors: *Geomorphology, *Hydrographs, *Model studies, *Rainfall-runoff relationships, *Saudi Arabia, Infiltration, Philips expression, Rainfall.

A watershed discharge hydrograph simulation model was presented, based on the hydraulically based geomorphologic instantaneous unit hydrograph (IUH). This IUH was derived as a function of watershed geomorphology and the response of streams to lateral inflows, determined by solving one-dimensional linearized equations of motion. The effective rainfall was calculated here to be equal to the gross rainfall minus the infiltration losses, presented with Philip's expression coupled with an empirical equation for soil moisture computation. Consideration was given to the role of mountainous terrain in runoff generation. For mountainous watersheds, the mountain runoff is regarded as a water depth on the alluvial channels. The effective rainfall depth was calculated to be equal to this water depth plus the rainfall depth minus the infiltration losses. The simulation model was verified through applications for three gauged watersheds in Saudi Arabia. A comparison was made between the observed and simulated hydrographs, and an evaluation of the model results and limitations was provided . (Author's abstract)
W90-08279

EFFECTIVE RAINFALL ESTIMATION METHODS.
Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.
A. S. Patwardhan, J. L. Nieber, and E. L. Johns.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 2, p 182-193, March/April 1990. 6 fig, 2 tab, 12 ref.

Descriptors: *Effective precipitation, *Estimating equations, *Irrigation engineering, *Soil water, *Soil-water-plant relationships, Annual precipitation, Crop production, Rainfall, Rate of return, Soil properties.

In the design and operation of irrigation systems it is becoming increasingly important to account for the contribution made by natural rainfall in crop production. Numerous methods for estimating effective rainfall have been proposed in the past, including: direct measurement techniques; empirical methods; and soil water balance computations. A soil water balance model (SWBM) for estimating effective rainfall was used to test the accuracy of the United States Department of Agriculture Soil Conservation Service (USDA-SCS) and the Hershfield effective rainfall estimation methods for a well-drained soil and for a poorly-drained soil.

Estimates of mean annual monthly effective rainfall by the Hershfield method were found to compare closely with estimates from the SWBM for the well-drained soil but not for the poorly-drained soil. Effective rainfall estimates by these two methods for either soil condition did not compare well with the SWBM estimates for annual events with return periods higher than the mean annual event. (Author's abstract)
W90-08356

EFFECTS OF CLIMATE CHANGE ON U.S. IRRIGATION.
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
D. F. Peterson, and A. A. Keller.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 2, p 194-210, March/April 1990. 3 fig, 2 tab, 23 ref.

Descriptors: *Climatic changes, *Geographic information systems, *Global warming, *Greenhouse effect, *Irrigation districts, *Irrigation engineering, Agricultural hydrology, Cultivated lands, Evapotranspiration, Prediction, Water supply development.

Warming of the global atmosphere by 2-5 C, and regional changes in precipitation by the mid-21st century as greenhouse gases double, is expected. A composite model predicts the consequences on the geography of U.S. irrigation. Percentages of cultivated area irrigated are projected for each state. Predictions of actual area irrigated, which will depend on economic conditions and availability of new water supplies, are not made. In all cases percentages irrigated rise, with the greatest impact of a warmer climate on the agricultural economy in the Western states. In the Western states this will occur because of decreases in total area cultivated due to a loss of rainfall agriculture. In the East, irrigation will increase, accompanied by some decrease in cultivated areas. Improved use of technologies could help meet increasing evapotranspiration needs, but large new surface supplies will generally be required to maintain or increase present levels of irrigation. (Author's abstract)
W90-08357

SHORT-TERM PRECIPITATION PATTERNS IN CENTRAL HONSHU, JAPAN: CLASSIFICATION WITH THE FUZZY C-MEANS METHOD.
Meteorological Research Inst., Yatabe (Japan).
F. Fujibe.
Journal of the Meteorological Society of Japan JMSJAU, Vol. 67, No. 6, p 967-983, December 1989. 13 fig, 2 tab, 30 ref.

Descriptors: *Cluster analysis, *Cyclonic precipitation, *Japan, *Meteorology, *Precipitation mapping, *Tropical cyclones, Algorithms, Meteorological data, Mountains, Orographic precipitation, Spatial distribution, Synoptic analysis, Weather data collections, Weather patterns.

Extratropical cyclones are an important source of precipitation in Japan. Spatial patterns of short-term precipitation in central Honshu were classified by using the fuzzy c-means method (FCM). This is similar to cluster analysis except that each data element is allocated to all clusters with variable weight. The original algorithm was modified into a form suitable for classifying precipitation patterns and applied to 403 cases selected from data for nine years. The classification of highest resolution consists of thirteen clusters, while most cases of intense cyclones belong to the six major ones. A composite analysis on synoptic fields reveals that these six clusters include three types of pressure patterns. Orographic effects on precipitation are most conspicuous in the cluster which corresponds to the warm sector and cold fronts. In this cluster, a rain shadow exists to the east of the Central Mountain Region under strong southwesterly winds. On the other hand, clusters which correspond to the northern portion of cyclones show only a slight increase in precipitation to the south-southeast of mountain regions. (Author's abstract)
W90-08365

ORGANIZATION AND STRUCTURE OF CLOUDS AND PRECIPITATION ON THE MID-ATLANTIC COAST OF THE UNITED STATES: III. THE EVOLUTION OF A MIDDLE-TROPOSPHERIC COLD FRONT.
Washington Univ., Seattle. Dept. of Atmospheric Sciences.
J. E. Martin, J. D. Locatelli, and P. V. Hobbs.
Monthly Weather Review MWREAB, Vol. 118, No. 2, p 195-217, February 1990. 29 fig, 22 ref. National Science Foundation Grants ATM-8311147 and ATM-8809061.

Descriptors: *Climatology, *Meteorology, *Precipitation, *Weather patterns, Advection, Clouds, Meteorological data, Seasonal variation, Structural models, Thunderstorms.

A complex middle-tropospheric frontal structure, associated with various weather as it progressed across the United States, had a role in the production of precipitation in the eastern third of the United States. The frontal structure consisted of two features: a middle-tropospheric cold front associated with a strong 500 mb short wave that moved eastward from the Pacific Ocean, and a leeside warm front that formed in a northward sloping zone of warm-air advection associated with a trough in the lee of the Rocky Mountains. An analysis of the structure and progression of the middle-tropospheric frontal system showed that (1) a lee-side trough developed east of the Rocky Mountains in response to the adiabatic warming produced by the westerly flow across the mountains; (2) the 3-D structure of the leeside trough resulted in a frontogenetical circulation, which produced a warm front in a zone of warm-air advection east of the leeside trough; (3) when a short wave at 500 mb and an associated middle-tropospheric cold front overtook the trough and the warm front, a middle-tropospheric occluded-like structure formed; (4) the lifting associated with the eastward advance of the cold front triggered a line of thunderstorms in the lower Mississippi River Valley; (5) it is suggested that lee troughs and drylines are formed by similar physical processes, with seasonally varying factors accounting for differences between the two features; and (6) the structure and formation of this frontal system is inadequately described by present conceptual models. (Fish-PTT)
W90-08366

STRUCTURE OF A WINTER STORM PRODUCING HEAVY PRECIPITATION OVER NOVA SCOTIA.
Atmospheric Environment Service, Downsview (Ontario).
R. E. Stewart, C. A. Lin, and S. R. Macpherson.
Monthly Weather Review MWREAB, Vol. 118, No. 2, p 411-426, February 1990. 19 fig, 26 ref.

Descriptors: *Canada, *Meteorology, *Nova Scotia, *Precipitation, *Weather patterns, Coasts, Convective precipitation, Freezing, Marine climates, Melting, Meteorological data, Precipitation mapping, Radar, Rainfall, Snow, Storms, Structural models, Wind velocity.

On February 22, 1986 Nova Scotia experienced heavy precipitation in the form of snow, freezing precipitation, and rain from a storm having a central pressure no lower than 99.3 kPa. Using observations obtained during the Canadian Atlantic Storms Program (CASP) field project, the mesoscale structure of this storm was investigated. Throughout much of the storm, the lowest 1-3 km of the atmosphere over the coastline was near 0 C as a result of the diabatic process of melting and refreezing. Convergent flow aloft and the trajectories of particles undergoing terminal velocity changes contributed to enhanced precipitation near the coastline that was sometimes detected by radar as a precipitation band straddling the coastline. A mesoscale circulation, driven by melting and forced to remain linked to the coastline between the warm ocean and the cold land, is consistent with the observations. (Author's abstract)
W90-08367

CONTRAST IN WINTER RAINWATER COMPOSITION: MARITIME VERSUS CONTINENTAL RAIN IN EASTERN NORTH CAROLINA.
North Carolina Univ. at Wilmington.
For primary bibliographic entry see Field 5B.
W90-08368

ISOTOPIC COMPOSITION OF PRECIPITATION FROM TWO EXTRATROPICAL CYCLONES.
City Coll., New York. Dept. of Earth and Planetary Sciences.
S. D. Gedzelman, and J. R. Lawrence.
Monthly Weather Review MWREAB, Vol. 118, No. 2, p 495-509, February 1990. 17 fig, 5 tab, 29 ref. NSF grants ATM 84-19965 and ATM 84-20333.

Descriptors: *Chemistry of precipitation, *Climatic data, *Climatology, *Cyclonic precipitation, *Isotope studies, *Meteorologic data, *Meteorology, *Tropical cyclones, Air temperature, Calibrations, Clouds, Convective precipitation, Evaporation, Oxygen isotopes, Stratification, Synoptic analysis, Water sampling, Water vapor.

Precipitation samples were collected at stations in the Eastern United States for two extratropical cyclones during the Genesis of Atlantic Lows Experiment (GALE) of 1986 and analyzed for their delta-O18 values. They represent the first synoptic-scale datasets of isotopic values. Measured isotope ratios are explained in terms of physical principles and meteorological processes. They are shown to be related to vertical profiles of w, cloud-top temperatures, evaporation beneath cloud base, isotope equilibration, and water vapor sources for the precipitation. Measured isotope ratios are then compared to values obtained from simple models of convective and stratiform precipitation. Both storms are shown to exhibit a consistent pattern of isotope ratios, with lowest delta-O18 values occurring in the stratiform precipitation well within the cold air, and highest values associated with the convective precipitation of the warm sector. A pronounced-amount effect, in which delta-O18 values decrease as rainfall totals increase, is also identified at many stations. The isotopic databases from these storms may prove useful in deriving physical calibrations for climatological relationships between mean annual surface temperature or precipitation amount and the delta-O18 value of its precipitation for both present and past climate patterns. (Author's abstract)
W90-08369

ACID STRESS AND AQUATIC MICROBIAL INTERACTIONS.
For primary bibliographic entry see Field 5C.
W90-08414

EFFECTS OF LAKE ACIDIFICATION ON MICROBIAL POPULATIONS AND PROCESSES.
Brock Univ., St. Catharines (Ontario). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W90-08416

MAP3S CHEMISTRY AND DATA ANALYSIS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 7A.
W90-08564

CONFERENCE ON CLIMATE AND WATER. VOLUME I.
For primary bibliographic entry see Field 2A.
W90-08565

CLIMATIC CONDITIONS OF THE FUTURE.
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR). Research Dept.
M. I. Budyko.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 9-25, 5 fig, 26 ref.

Descriptors: *Climatology, *Global warming, *Greenhouse effect, *Precipitation forecasting, Analog method, Climatic changes, Data processing, Forecasting, Simulation analysis.

In recent years it has been widely acknowledged that predicting the future climatic conditions is of great practical importance, particularly in regard to global climate changes due to the greenhouse effect. Existing methods of evaluating future climates are all approximate. Therefore, the approach generally applied is to compare the results of two or more independent methods of calculation and interpret good agreement as proof of validity. One of the variants of such an approach while predicting future climatic conditions is to compare the results of theoretical calculations by climate simulations with the results obtained by empirical methods, the climate analogue method having acquired by now the principal meaning. A review of methodologies and historical perspective is presented. Topics covered include: (1) the rationale for the use of the analog method; (2) prediction of future temperature regimes by empirical data and by climate simulations; (3) prediction of precipitation; and (4) the validity of information about expected climatic changes. (See also W90-08565) (White-Reimer-PTT)
W90-08566

PROJECTED CLIMATIC CHANGES AND IMPACTS IN EUROPE DUE TO INCREASED CO2.
Muenster Univ. (Germany, F.R.). Center for Applied Climatology and Environmental Studies.
W. Bach.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 31-50, 5 fig, 1 tab, 44 ref.

Descriptors: *Carbon dioxide, *Climatic changes, *Climatology, *Europe, *Global warming, *Greenhouse effect, *Model studies, Data processing, General circulation models, Political aspects, Projections, Seasonal variation.

In spite of global and regional climatic fluctuations, the observed climatic changes in the past can serve as a benchmark for climatic changes in the future. There are two main approaches for assessing the patterns of climatic change in a future warmer world. One is the analog method in which the regional and seasonal patterns of past warm climates are used to construct warm-world scenarios as analogs for a future CO2-induced warm climate. The second is the physical method which assesses the behavior of the climate system on the basis of fundamental physical laws using climate modeling. General circulation models (GCMs) have three main components, a GCM of the atmosphere, a heat and water balance model of the continental surface, and some scheme to incorporate the ocean. Although these models are not yet realistic enough to give reliable estimates on the detailed scales required for impact analysis, they can be used to construct scenarios of possible climatic change. The most direct approach to model validation is to compare model-generated data with recent observations over a variety of space and time scales. Using a comparison of several models seasonal temperature and precipitation change were examined for Europe, the boreal and sub-arctic zone, the coastal lowlands, the central European lowlands, the mountain ranges, and the Mediterranean region. The political action needed in view of these projections includes: (1) A revision of the Montreal Protocol with the goal of a complete phaseout of all halocarbons by year 2000; (2) an agreement upon an upper warming ceiling and the resulting reduction plans for the major greenhouse gases; (3) an intensive research program emphasizing both impact analysis and the assessment of the emission reduction potential of all major climate-influencing factors; (4) more emphasis on preventive than on curative measures; (5) a transfer of best available technology and know-how from industrialized to developing countries; and (6) and aid program with compensation payments to restore and preserve the forests and soils in the Third World. (See also W90-08565) (White-Reimer-PTT)

W90-08567

SIMULATION OF THE IMPACT OF CO2 ATMOSPHERIC DOUBLING ON PRECIPITATION AND EVAPOTRANSPIRATION--STUDY OF THE SENSITIVITY TO VARIOUS HYPOTHESES.
Institut Royal Meteorologique de Belgique, Brussels. Hydrology Section.
F. Bultot, and D. Gellens.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 73-92, 2 fig, 4 tab, 18 ref.

Descriptors: *Carbon dioxide, *Climatic changes, *Climatology, *Evapotranspiration, *Global warming, *Greenhouse effect, *Humidity, *Model studies, *Precipitation, Belgium, General circulation models, Sensitivity analysis, Simulation.

In the CO2 doubling scenarios, based on the results yielded by General Circulation Models (GCM), and currently used to simulate the hydrological impact, two hypotheses are generally made. One of these is that the number of precipitation days remains unchanged. The second hypothesis deals with the relative humidity. This element is kept equal to its present value. Hence, the increased temperature implies increased values of both the water vapor pressure and the saturation deficit. Modifications were made in this hypothesis in a scenario and sensitivity analysis for Belgium. The frequency of precipitation days was not kept constant, but was set to vary in terms of the monthly precipitation amount. Secondly, the water vapor pressure was estimated by assuming that the relative humidity reaches 95%, 100%, 105%, and 110% of its present value. The scenario results indicated: (1) a strengthening of both the potential and effective evapotranspiration throughout the year; (2) a shortening of the spells with snow cover; and (3) a strengthening of the surface flow throughout the winter season. The sensitivity studies showed that any increase in relative humidity leads to a systematic decrease in potential evapotranspiration. Secondly, as long as the number of precipitation days is assumed not to change, and when the increments in winter precipitation are distributed according to a proportional rule, the probability of occurrence of heavy daily precipitation is necessarily greater. However, as soon as the precipitation days is assumed to change according to the mean relationship currently observed between precipitation days and the monthly rainfall amount, the frequency distribution of the daily precipitation remains close to what it is at present. (See also W90-08565) (White-Reimer-PTT)
W90-08568

LONG-TERM VARIABILITY OF PRECIPITATION IN AUSTRIA.
Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewaesserkunde und Wasserwirtschaft.
O. Behr.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 93-102, 4 fig, 5 ref.

Descriptors: *Austria, *Climatology, *Meteorological data collection, *Precipitation, Danube River Basin, Data processing, International agreements, Variability, Water management.

Long-term characteristics of precipitation are a major input variable to many problems in water management. Fluctuations of long time series together with regional variability, therefore, have been investigated in Austria using monthly precipitation data. The results indicate spatial patterns of long-term variability dominated by the Alps. It was shown that annual or even seasonal values may by insufficient for assessing trends. Thus monthly data should be preferred. Observation data also indicate that the conventional conception of a stable long-term mean does not apply to precipitation and thus careful consideration of variability of precipitation is indispensable. The problems of assessing the long-term spatial patterns of precipitation fluctuations in an area as small as

Austria led to a joint project of all Danube countries within the framework of the International Hydrological Program of UNESCO in 1988. (See also W90-08565) (Author's abstract)
W90-08569

LONG TERM VARIATIONS OF THE WATER BALANCE IN SWEDEN--A PRELIMINARY STUDY.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
For primary bibliographic entry see Field 2A.
W90-08570

CHANGES OF PRECIPITATION IN FINLAND.
Finnish Meteorological Inst., Helsinki.
R. Heino.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 111-120, 5 fig, 1 tab, 6 ref.

Descriptors: *Climatology, *Finland, *Meteorological data, *Precipitation, Gages, Historical records, Long-term patterns, Seasonal variation.

A review of long-term changes of precipitation in Finland is presented. Changes of precipitation gages as well as relocations of stations and other environmental changes explain much of the long-term changes of precipitation. The standard deviations reveal that the variability of seasonal and annual precipitation was greatest in the middle of the century while the present variability has generally been greater than in the first decades of the century. Taking into account the main sources of inhomogeneity some general features of precipitation changes can be shown. They include: a long-term decrease in southern Finland and a recent increase in the middle parts of the country, while in the north the changes have been small. (See also W90-08565) (Author's abstract)
W90-08571

MEDITERRANEAN OSCILLATION: IMPACT ON PRECIPITATION AND HYDROLOGY IN ITALY.
Servizio Meteorologico dell'Aeronautica, Rome (Italy).
M. Conte, A. Giuffrida, and S. Tedesco.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 121-137, 11 fig, append.

Descriptors: *Climatology, *Hydrology, *Italy, *Mediterranean, *Precipitation, *Weather patterns, Algiers, Cairo, Climatic changes, Drought, Long-term patterns, Oscillations, Weather.

An analysis was carried out on the 500 hPa height over the Mediterranean since 1946 by using the Algiers and Cairo as representative stations for the western and eastern Mediterranean basins, respectively. An oscillatory increase of the 500 hPa height at Algiers is quite evident from the analysis, in exact phase-opposition with an oscillatory decrease of the height at Cairo. This opposite behavior of the 500 hPa height in the western and the eastern Mediterranean region defines a Mediterranean Oscillation in which an increase of height in the western basin is accompanied by a decrease in the eastern one and vice-versa. An interesting aspect is a positive and significant linear trend in the 500 hPa heights of the western and the central Mediterranean (with a negative trend in the eastern basin) which is evident during the cold season. Both the oscillation and the positive trend could be an indication that, in spite of successive advances and retreat, a cell of the subtropical anticyclone is going slowly to invade the western and the central Mediterranean. The severe drought of the cold season 1988-1989 is also characterized with its effects on river flow and the problem of some water reservoirs. (See also W90-08565) (White-Reimer-PTT)
W90-08572

Group 2B—Precipitation

EFFECT OF CLIMATE CHANGE ON EVAPO-RATION AND WATER TEMPERATURE.
Institute of Meteorology and Water Management, Warsaw (Poland).
D. Jurak.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 138-148, 6 tab, 9 ref.

Descriptors: *Climatic changes, *Climatology, *Evaporation, *Global warming, *Greenhouse effect, *Holomictic lakes, *Water temperature, Aquatic environment, Carbon dioxide, Heat transfer, Hydrologic budget, Meteorological data, Meteorology, Model studies, Poland, Shallow lakes, Temperature.

A method for assessing climate impacts on shallow (non-stratified) aquatic bodies is presented. The model is designed to calculate the water temperature, heat exchange characteristics and evaporation losses using standard meteorological data. It was extensively tested for the present climate conditions and used for calculating thermal regime and free-water evaporation for a number of lakes and reservoirs in Poland. Assuming general circulation model based changes of climatic parameters under the hypothesis of CO_2 doubling, calculations of temperature and evaporation were done for three locations in Poland with differentiated climatic conditions. The results showed that for the mid-altitude regions the mean monthly temperature of water may rise from 0.9 C to 1.5 C, depending on the month. Evaporation values will increase from energy and water balance of water bodies, and consequently change their physical, biological and chemical properties. (See also W90-08565) (Author's abstract)
W90-08573

ATMOSPHERIC TRANSPORT OF HEAT AND WATER: A REVIEW.
Helsinki Univ. (Finland). Dept. of Meteorology.
For primary bibliographic entry see Field 2A.
W90-08574

VALIDATION OF RESIDUAL ENERGY BUDGETS FROM ATMOSPHERIC CIRCULATION DATA AGAINST SATELLITE MEASUREMENTS OF THE NET RADIATION.
Helsinki Univ. (Finland). Dept. of Meteorology.
For primary bibliographic entry see Field 2A.
W90-08575

DETERMINATION OF AREAL EVAPOTRANSPIRATION FROM SATELLITE DATA USING A TEMPERATURE/SURFACE FLUXES INVERSION MODEL.
National Board of Waters, Helsinki (Finland).
For primary bibliographic entry see Field 7B.
W90-08576

CHARACTERIZATION OF HYDROMETEOROLOGICAL ELEMENTS.
Budapesti Mueszaki Egyetem (Hungary). Dept. of Water Supply Management.
For primary bibliographic entry see Field 2A.
W90-08577

POSSIBLE CHANGES IN FOREST HYDROLOGY FOLLOWING A GLOBAL CLIMATIC CHANGE.
Groningen Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 2I.
W90-08578

LONG TERM EVOLUTION OF THE ITALIAN CLIMATE OUTLINED BY USING THE STANDARDIZED ANOMALY INDEX (SAI).
Servizio Meteorologico dell'Aeronautica, Rome (Italy).
For primary bibliographic entry see Field 7C.
W90-08579

CHANGING SYNOPTIC WEATHER PATTERNS, RAINFALL REGIMES AND ACID INPUTS IN THE EAST MIDLANDS, U.K.
Loughborough Univ. of Technology (England). Dept. of Geography.
R. Wilby.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 209-218, 2 fig, 2 tab, 9 ref.

Descriptors: *Acid rain, *England, *Model studies, *Precipitation, *Weather patterns, Climatic changes, East Midlands, Forecasting, Hydrogen ion concentration, Sulfur, Synoptic analysis.

The significance of synoptic variations over time-scales of 10-100 years for inputs of acidic ions to catchment hydrochemical systems was investigated. A methodology is presented for the use of the Lamb's Weather Type register to both reconstruct and to predict future rainfall amounts and acidities. A number of predictions were made for the East Midlands, England, on the basis of recent and contemporary synoptic trends using the Shifting Climate and Catchment Acidification Model (SCAM) model. Coupled with the steady decline in the level of SOx emissions in the U.K. for the last 20-years, the predicted changes to the Climatic Index of Acidification suggest a stable condition for the East Midlands over the next 25-years, where the 'acid rain' problem is concerned. Although an increase in the frequency of the westerly-type is forecasted, any benefits arising from this shift appear to be more than offset by coincident increases in the cyclonic and anticyclonic proportions. Whether or not the slight increases in the H-ion load predicted by SCAM--assuming 1988 emission levels--will be significant in terms of both the response of catchment ecosystems and of surface water quality changes is unclear. (See also W90-08565) (Author's abstract)
W90-08580

ANNUAL RAINWATER POTENTIAL AND ITS VARIABILITY IN DROUGHT YEARS OVER ETHIOPIA.
National Meteorological Services Agency, Addis Ababa (Ethiopia).
A. Yeshanew, and G. Apparao.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 219-235, 5 fig, 4 tab, 4 ref.

Descriptors: *Africa, *Climatology, *Drought, *Ethiopia, *Rainfall, Crop production, Famine, Irrigation, Seasonal variation.

Ethiopia receives rainfall mainly during two seasons, namely 'Belg' (small rains from February to May) and 'Kiremt' (big rains from June to September). The food production for the country is highly dependent on rainfall because irrigation is insufficient. In recent years, the country has faced many droughts due to untimely and deficient rains, sometimes leading to famines. Based on station rainfall data, the administrative regional averages on a monthly basis have been computed. These monthly data were used to compute the volume of rainwater series for the country, taking into account the area of each region for the period under consideration. The average of rainfall volume for the period from 1969 to 1987 was taken as the normal annual rainwater volume over the country. The total volume of rainwater released over Ethiopia showed that nearly 56% and 31% of the annual values are obtained during Kiremt and Belg respectively. The marked years of low rainwater were 1972, 1973, 1974, and 1984. The spatial distribution of the rainwater of 1984, the most deficient year, indicated that most of the regions were deficient from -10% to -49%, as both Belg and Kiremt failed badly in this year. The study indicated that the country is rich in water, released by rain with low interannual variations. The physical reason for the occurrence of rainfall deficiency over Ethiopia is due to the weakening or the absence of thermo-dynamic and dynamic conditions that generate rain over the country. (See also W90-08565) (Author's abstract)
W90-08581

SENSITIVITY OF EVAPOTRANSPIRATION AND SOIL MOISTURE TO POSSIBLE CLIMATIC CHANGES.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2D.
W90-08582

SOIL MOISTURE DYNAMICS IN SOUTH-CENTRAL SWEDEN IN A 100 YEAR PERSPECTIVE.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
For primary bibliographic entry see Field 2G.
W90-08583

MONITORING OF VEGETATION PERIOD COURSE OF SOIL MOISTURE BASED ON MEASUREMENTS AND EVALUATION IN HUNGARY.
Kozponti Meteorologiai Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2G.
W90-08584

HYDROLOGICAL MODELING OF HAPEX REGION USING SATELLITE OBSERVATIONS.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
For primary bibliographic entry see Field 2A.
W90-08585

LANDSCAPE INFLUENCE ON LAND-ATMOSPHERE HEAT MOISTURE EXCHANGE AND ITS VARIABILITY.
Gosudarstvennyi Gidrologicheskii Inst., Valdai (USSR).
For primary bibliographic entry see Field 2D.
W90-08586

ESTIMATION OF AVAILABLE WATER-HOLDING CAPACITY OF SOILS IN EUROPE.
International Soil Reference and Information Centre, Wageningen (Netherlands).
For primary bibliographic entry see Field 2G.
W90-08587

SNOW AND ICE--NONRENEWABLE NATURAL RESOURCES IN THE FUTURE.
National Board of Waters, Helsinki (Finland).
For primary bibliographic entry see Field 2C.
W90-08588

INFLUENCE OF GLACIERISATION ON THE RESPONSE OF RUNOFF FROM ALPINE BASINS TO CLIMATE VARIABILITY.
Victoria Univ. of Manchester (England). Alpine Glacier Project.
For primary bibliographic entry see Field 2C.
W90-08589

150 YEARS SINCE G. G. HALLSTROM'S STUDIES ON ICE BREAK-UP DATES AS CLIMATIC INDICATORS.
National Board of Waters, Helsinki (Finland). Water and Environment Research Inst.
For primary bibliographic entry see Field 2C.
W90-08590

SIMULATION OF THE EFFECTS OF CLIMATE CHANGES ON A GLACIER IN WESTERN NORWAY.
Norges Vassdrags- og Elektrisitetsvesen, Oslo.
For primary bibliographic entry see Field 2C.
W90-08591

CLIMATE VARIATION AND ICE CONDITIONS IN THE RIVER TORNEALVEN.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
For primary bibliographic entry see Field 2C.

W90-08592

EFFECTS OF CLIMATE VARIABILITY AND CHANGE ON FRESH WATER BODIES.
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
For primary bibliographic entry see Field 2A.
W90-08593

CLIMATE AND LAKES.
Leningrad Hydrometeorological Inst. (USSR).
For primary bibliographic entry see Field 2H.
W90-08594

THERMAL CHARACTERISTICS OF LAKES AS A MEASURE OF CLIMATE CHANGE.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
For primary bibliographic entry see Field 2H.
W90-08595

JOINT APPLICATION OF TREND TESTING AND HYDROLOGICAL MODELS IN DISTINGUISHING BETWEEN HUMAN INFLUENCES AND CLIMATIC EFFECTS ON THE HYDROLOGICAL CYCLE.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2A.
W90-08596

ESTIMATING THE IMPACTS OF CLIMATIC CHANGE ON RIVER FLOWS: SOME EXAMPLES FROM BRITAIN.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W90-08597

CLIMATE-INDUCED EFFECTS ON THE WATER BALANCE--PRELIMINARY RESULTS FROM STUDIES IN THE VARPINGE EXPERIMENTAL RESEARCH BASIN.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 2A.
W90-08598

LONG-TERM TRENDS IN RIVER FLOW IN FINLAND.
National Board of Waters, Helsinki (Finland). Water Research Inst.
For primary bibliographic entry see Field 2E.
W90-08599

WATER BALANCE INVESTIGATIONS IN SWISS ALPINE BASINS--TOOL FOR THE IMPROVED UNDERSTANDING OF IMPACTS OF CLIMATIC CHANGES ON WATER RESOURCES.
Service Hydrologique National, Bern (Switzerland).
For primary bibliographic entry see Field 2A.
W90-08600

GRADUAL CLIMATE CHANGE AND RESULTING HYDROLOGIC RESPONSE.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2A.
W90-08601

EFFECT OF CLIMATE VARIABILITY AND CHANGE ON GROUNDWATER IN EUROPE.
Aarhus Amtskommune (Denmark). Groundwater Dept.
For primary bibliographic entry see Field 2F.
W90-08602

MULTIANNUAL VARIATIONS OF GROUNDWATER IN FINLAND DURING THE YEARS 1962-1989.
National Board of Waters, Helsinki (Finland). Water Research Inst.
For primary bibliographic entry see Field 2F.

W90-08603

IMPACT OF CLIMATE CHANGE ON GROUNDWATER RECHARGE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2F.
W90-08604

2C. Snow, Ice, and Frost

TUNED PERFECT PROGNOSIS FORECASTS OF MESOSCALE SNOWFALL FOR SOUTHERN ONTARIO.
Atmospheric Environment Service, Downsview (Ontario). Meteorological Services Research Branch.
W. R. Burrows.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 3, p 2127-2141, February 28, 1990. 4 fig, 9 tab, 23 ref.

Descriptors: *Meteorology, *Ontario, *Snow, *Snow accumulation, *Statistical models, *Weather forecasting, Data interpretation, Mesoscale models, Meteorological data, Performance evaluation, Statistical analysis, Statistical methods.

A procedure for producing site-specific 1 and 2-day categorical forecasts of 24-hour accumulated snowfall by statistical forecast methods has been developed and tested for a small area of Ontario adjacent to southern Georgian Bay. A perfect prognosis (perfect prog, or PP) method was used, with predictors designed to handle lake-effect and nonlake-effect snowfall. Predictors were selected from a basic set of potential predictors by a stepwise multiple discriminant analysis (MDA) procedure done in three stages, where the third stage involved adding functions of predictors already selected in the first two stages to the basic predictor set. The third stage appears to enhance the discriminating power of the original predictor set because the number of 'hits' of snowfall forecasts made with independent data was significantly increased and distribution of forecasts was brought closer to the observed distribution. A two-step, rule-based tuning procedure was applied to the PP-MDA forecasts to help compensate for errors that arise when the PP-MDA statistical equations are used with numerical weather prediction model data, and for errors that arise from the conservative nature of MDA forecasts. A rule-based nonparametric statistical classification procedure (Classification and Regression Trees, or CART) was used in the first step. When the rules for tuning forecasts were tested with independent data, CART was found to increase the skill of the tuned forecasts, particularly in the common categories (1,2) and to improve the reliability of category 1 forecasts at a majority of the stations. However, CART was unable to find rules for infrequent and rare snow categories. Step B of the tuning procedure, a semicomputerized manual search for additional rules not seen by CART, was undertaken in an attempt to 'do something' about this problem. When tested with independent data, overall improvement was found in the skill of forecasts tuned by two-step procedure, but it was too small to make an appreciable difference. (Author's abstract)
W90-07585

HYDROLOGIC SENSITIVITIES OF THE SACRAMENTO-SAN JOAQUIN RIVER BASIN, CALIFORNIA, TO GLOBAL WARMING.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-07640

MULTIYEAR TRENDS IN SNOWPACK ION ACCUMULATION AND LOSS, NORTHERN MICHIGAN.
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5B.

W90-07680

DETERMINATION OF A Z-R RELATIONSHIP FOR SNOWFALL USING A RADAR AND HIGH SENSITIVITY SNOW GAUGES.
Hokkaido Univ., Sapporo (Japan). Inst. of Low Temperature Science.
For primary bibliographic entry see Field 7C.
W90-07822

MASS-DIMENSIONAL RELATIONSHIPS FOR ICE PARTICLES AND THE INFLUENCE OF RIMING ON SNOWFALL RATES.
Nevada Univ., Las Vegas. Desert Research Inst.
D. L. Mitchell, R. Zhang, and R. L. Pitter.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 2, p 153-163, February 1990. 14 fig, 2 tab, 20 ref.

Descriptors: *Ice formation, *Meteorology, *Particle size, *Precipitation, *Precipitation rate, *Snow, Aggregation, Orographic precipitation, Photomicrography, Regression analysis, Rime, Winter storms.

An understanding of the development of precipitation in glaciated or mixed-phase clouds often requires knowledge of the size dependence of ice particle masses. The masses, dimensions, and habits of over 2800 natural ice particles precipitating from orographic winter storms in the central Sierra Nevada were obtained using photomicrographs. Ice particles that could be unambiguously classified were used to generate empirical expressions relating snow particle masses and dimensions. Many of the ice particle types had not been investigated previously. The influence of riming and aggregation on ice particle masses was examined. When possible, comparisons are made between these results and those of other experimental observations. By incorporating these mass-dimensional relationships into an expression for the ice mass content in a snowstorm, it was possible to estimate the mass fraction of the fresh snowpack resulting from accreted supercooled cloud water. The results from two storms analyzed suggest that about 30 to 40 percent of the deposited snow is composed of accreted cloud water during moderately rimed snowfall. (Author's abstract)
W90-07823

ALBEDO DECAY OF PRAIRIE SNOWS.
Minnesota Univ., St. Paul. Dept. of Soil Science.
D. G. Baker, D. L. Ruschy, and D. B. Wall.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 2, p 179-187, February 1990. 6 fig, 7 tab, 22 ref.

Descriptors: *Albedo, *Deterioration, *Snow, *Snow accumulation, Reflectance, Regression analysis, Seasonal variation, Snow cover.

Daily albedos of snow were measured between November and April, 1969-87, and analyzed to determine the decay rate between snowfalls. The data essentially represent the snow accumulation season because the analysis was limited to days when snow depth and albedo were at least 10.2 cm and 50%. These criteria served to limit, if not eliminate, the snowmelt period or any effect of the underlying surface. In the 18 winters a total of 232 individual runs (day between snowfalls) of albedo decay varying from 1 to 21 days in duration were found and analyzed. None of the factors considered in the aging process of snow (temperature, heat sums, sunshine, solar altitude, and time) could be used individually to successfully predict the albedo decay of single runs. A relatively strong relationship, however, was found between the mean albedos and the number of days since the last measurable snowfall. The relationship with heat sums, which by their very nature include time as a factor, was weaker. Thus, within the time limits imposed upon the albedo data used, the mean albedo decay between snowfalls can be successfully predicted only by the number of days in that interval. The mean decay rates for all months and combinations of months were generally described equally as well by linear trends as by exponential

trends, in contrast to the exponential decay usually depicted. The mean linear decay rate of the December through February period < 1%/day in contrast to the November, March and April linear rates that were 2.4, 2.9, and 3.3%/day,m. The mean albedo on the day following a snowfall greater than a trace averaged about 80% during the November through April period. (Author's abstract)
W90-07824

SOOT IN THE ATMOSPHERE AND SNOW SURFACE OF ANTARCTICA.
Washington Univ., Seattle. Dept. of Atmospheric Sciences.
S. G. Warren, and A. D. Clarke.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 2, p 1811-1816, February 20, 1990. 1 fig, 1 tab, 30 ref. NSF Grant DPP-83-16220.

Descriptors: *Air pollution, *Albedo, *Antarctica, *Snow cover, *Soot, Carbon, Filtration, Light penetration, Reflectance.

Samples of snow collected near the south pole during January and February 1986 were analyzed for the presence of light-absorbing particles by passing the melted snow through a nucleopore filter. Transmission of light through the filter showed that snow far from the station contains the equivalent of 0.1-0.3 ng C/gm of snow. Samples of ambient air were filtered and found to contain about 1-2 ng C/kg of air giving a scavenging ratio of about 150. The snow downwind of the station exhibited a well-defined plume of soot due to the burning of diesel fuel, but even in the center 1 km downwind, the soot concentration was only 3 ng/gm of snow, too small to affect snow albedo significantly. Measurements of snow albedo near large inland stations are therefore probably representative of their surrounding region. (Author's abstract)
W90-07826

ATMOSPHERIC ICING RATES WITH ELEVATION ON NORTHERN NEW ENGLAND MOUNTAINS, U.S.A.
Cold Regions Research and Engineering Lab., Hanover, NH.
C. C. Ryerson.
Arctic and Alpine Research ATLPAV, Vol. 22, No. 1, p 90-97, February 1990. 9 fig, 19 ref.

Descriptors: *Ice formation, *Mountains, *Rime, Alpine regions, Clouds, Elevation, Ice, Madonna Peak, Mount Mansfield, Mount Washington, New Hampshire, Vermont, Wind.

Atmospheric rime icing, resulting primarily from supercooled cloud droplet impaction on objects at the Earth's surface, was monitored and analyzed as a function of elevation on the west faces of Madonna Peak and Mount Mansfield in the Green Mountains, Vermont, and at the summit of Mount Washington, New Hampshire. Measurements were made of ice accretion rates on passive, manually operated collection baskets and automatic ice detectors. Icing rates increase exponentially with elevation above about 800 m, with secondary controls of rate suggested by microtopographic relief exposure. The illustrated dependence of icing rate upon elevation is largely a function of New England wind and cloud regimes and differs from other selected mountainous locations. The relationships presented may help assess the magnitude of frozen moisture inputs to high-elevation mountain ecosystems. (Author's abstract)
W90-07874

SIMULATION OF SNOWMELT RUNOFF PATHWAYS ON THE LAC LAFLAMME WATERSHED.
Moncton Univ. (New Brunswick). Ecole de Sciences Forestieres.
R. Barry, M. Prevost, J. Stein, and A. P. Plamondon.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 103-121, February 1990. 7 fig, 4 tab, 28 ref.

Descriptors: *Atolls, *Geophysical exploration, *Hydrologic models, *Quebec, *Runoff, *Snowmelt, Hydraulic conductivity, Lysimeters, Soil porosity, Streamflow, Subsurface runoff, Surface runoff, Throughflow.

The contributions of subsurface and surface runoff to streamflow during snowmelt in a balsam fir forest located on a laurentidian upland watershed Lac Laflamme, Quebec were determined with a hydrologic model (HYFOR). Lysimeter and calculated snowmelt runoff at the base of the snowpack were used as an input to the model during the snowmelt period of 1985, 1986, and 1987. The calculated values were obtained from a temperature index snow cover model. The initial simulations showed a poor ability to predict runoff. The soil porosity and hydraulic conductivity were modified to account for the ground frost effect. Simulations were substantially improved by reducing soil porosities by 31% and hydraulic conductivities by 53% of their original values measured under the frost free conditions. Surface flow volume, which lumps rapid throughflow and overland flow, computed with the calibrated model varied between 32 and 47% of the total volume for the three snowmelt periods. Because of the significant modifications of soil parameters necessary to obtain reasonable model performance, it is concluded that better field observations on soil hydrologic properties are needed to improve snowmelt runoff simulations. (Author's abstract)
W90-07980

MODELLING SNOWMELT IN A MOUNTAINOUS RIVER BASIN ON AN EVENT BASIS.
Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft.
G. Bloschl, R. Kirnbauer, and D. Gutknecht.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 207-229, February 1990. 9 fig, 29 ref.

Descriptors: *Alpine regions, *Flood forecasting, *Model studies, *Rainfall-runoff relationships, *Snowmelt, Elevation, Energy-balance approach, Simulation analysis, Snowline.

A snowmelt model for short time flood forecasting of mixed rain-snowmelt floods in a high alpine watershed have been developed. The model is based on a subdivision of the basin into elevation bands. The energy input into the snowpack is computed by the energy-balance approach, using physically based preset parameters. The internal processes are parameterized by introducing heat and water storage capacities. The state of the snow cover throughout the basin is characterized by distinguishing three zones with different melt and drainage conditions. The lowest zone is saturated and runoff-producing. Above it, there is a transition zone of partly soaked snow. In the uppermost portion of the basin, no liquid water is stored in the snow. Snow line, saturation line and dry-snow line form the boundaries between the respective zones. In performing simulation runs, the three boundary lines are found to follow different patterns during a six-day test period. Due to the prevailing melt conditions, the snow line rises monotonically and is only slightly influenced by different weather conditions. The saturation line and consequently the bank width of the soaked zone, however, are controlled by day-to-day and diurnal changes in meteorological variables and exhibit a significant increase on rainy days and pronounced fluctuations during fair weather. The dry-snow line shows minor fluctuations. A sensitivity analysis indicates that the influence of model parameters on simulated melt rates is moderate or small when simulation periods of several days are considered so that parameters may be preset without inducing much additional uncertainty. The snowmelt routine was developed with the intention of starting it during the ablation period. Thus, initial conditions for the above mentioned boundary lines are required. Based on sensitivity analysis, it is found that the elevation of the snowline must be derived from current observations. For saturation line and dry-snow line, simple relations to air temperature are given. Simulation results indicate that the areal extent of the saturated snow cover must be considered if proper model performance for the first hours after model start is desired. (Author's abstract)

W90-07987

PROGRAMME AL GHAIT--MOROCCO WINTER SNOWPACK AUGMENTATION PROJECT: A COOPERATIVE PROJECT BETWEEN THE KINGDOM OF MOROCCO AND THE UNITED STATES.
Bureau of Reclamation, Denver, CO. Div. of Research and Lab. Services.
For primary bibliographic entry see Field 3B.
W90-08165

HYDROGRAPH SEPARATION IN A SMALL ALPINE BASIN BASED ON INORGANIC SOLUTE CONCENTRATIONS.
Colorado Univ., Boulder. Inst. of Arctic and Alpine Research.
For primary bibliographic entry see Field 2E.
W90-08219

PATTERN OF SOLUTE MOVEMENT FROM SNOW INTO AN UPPER MICHIGAN STREAM.
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2A.
W90-08434

SNOW AND ICE--NONRENEWABLE NATURAL RESOURCES IN THE FUTURE.
National Board of Waters, Helsinki (Finland).
E. Kuusisto.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 300-318, 10 fig, 23 ref.

Descriptors: *Climatic changes, *Global warming, *Ice cover, *Snow, Evaporation, Forecasting, Lakes, Model studies, Seas, Snowmelt, Vegetation.

The earth's climate will change in the next decades--possibly at a rate seldom exceeded in the past. The group of hydrological variables most sensitive to climatic changes will be the cryospheric ones, i.e. those related to snow and ice. Snow has several physical properties which strengthen the interactions with climate. For example, snow has the highest reflectivity and lowest thermal conductivity of the common natural surfaces. Feedbacks between snow cover and climate include: (1) snow-albedo-temperature; (2) snow-high pressure cells -polar outbreaks; (3) snowmelt-evaporation-Arctic stratus; and (4) snow line-elevation. The modeling of these and other feedbacks in global climatic models is still far from satisfactory. Many environmental factors will be involved in the long-term response of cryosphere to man-induced climatic changes. These include particularly the atmosphere-ocean interactions, which may have time-scales comparable to those between atmosphere and continental ice sheets. The long observation series of some cryospheric variables, notably those of the ice cover on lakes and marginal seas, will offer a good possibility for an early detection of short-term climatic change. (See also W90-08565) (White-Reimer-PTT)
W90-08588

INFLUENCE OF GLACIERISATION ON THE RESPONSE OF RUNOFF FROM ALPINE BASINS TO CLIMATE VARIABILITY.
Victoria Univ. of Manchester (England). Alpine Glacier Project.
D. N. Collins.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 319-328, 5 fig, 3 tab, 10 ref.

Descriptors: *Alpine regions, *Climatic changes, *Climatology, *Glaciers, *Glaciohydrology, *Global warming, *Runoff, *Switzerland, Altitude, Energy, Precipitation, Temperature.

Records of runoff from gages on rivers draining basins of between 1.9 and 66.6% glacier cover in

the Rhone catchment, Switzerland have been examined together with records of air temperature and precipitation for the period 1930-1987. Precipitation was more variable from year to year than thermal input. At higher levels of glacierization, energy input dominates runoff variability, but at low levels precipitation variation is the main influence. Considerable variations in discharge from highly-glacierized basins have resulted from underlying secular variations in energy inputs. Should glaciers continue to retreat under favorable energy-input conditions, percentage glacierization might be expected to fall, reducing the influence of energy variability on runoff and increasing dependence on precipitation. Average runoff amounts will probably be maintained, since the average area of bare ice exposed to melting will not shrink as the maximum annual elevation of the transient snowline on the glacier will rise. This will continue until the snowline rises above the upper limit of glacier cover at high altitude. (See also W90-08565) (Author's abstract)
W90-08589

150 YEARS SINCE G. G. HALLSTROM'S STUDIES ON ICE BREAK-UP DATES AS CLIMATIC INDICATORS.
National Board of Waters, Helsinki (Finland). Water and Environment Research Inst.
J. M. Kajander.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 329-338, 1 tab, 18 ref.

Descriptors: *Climatic changes, *Climatology, *Finland, *Global warming, *Hallstrom method, *Ice breakup, Data interpretation, Land use, Measuring data, Regression analysis.

The Hallstrom method first employed in Finland in 1839 of using ice break-up dates as indicators of climatic change is still relevant and now much easier to use. Hallstrom assumed that the date of break-up or freeze-up at any station would be a linear function of time. The results did not support the hypothesis of a universal trend and Hallstrom concluded that the climatic changes were local. The most marked result was the rapid cooling of the climate in Vasteras. The general opinion was that deforestation and drainage of swamplands would make the climate more temperate. The Neo-Hallstromian analysis for the more recent material was carried out with the standard period 1913-1988. Only a few stations showed statistically significant trends. Some of these can be explained by a local warming due to industry and urbanization, or by changes in discharge patterns. The freeze-up and break-up dates have never been very important as indicators of climatic variations. The value of cryophenological observations lies in the simplicity of the observation process and in the compactness of the information acquired. This will probably be important as a complement to meteorological data even in the future. (See also W90-08565) (Author's abstract)
W90-08590

SIMULATION OF THE EFFECTS OF CLIMATE CHANGES ON A GLACIER IN WESTERN NORWAY.
Norges Vassdrags- og Elektrisitetsvesen, Oslo.
T. Laumann, and A. M. Tvede.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 339-352, 8 fig, 12 ref.

Descriptors: *Climatic changes, *Climatology, *Glaciers, *Global warming, *Norway, Model studies, Precipitation, Seasonal variability, Simulation analysis, Temperature.

Throughout the last century, the relationship between the climate and the advance or retreat of the glaciers has been one of the key areas of research within glaciology. A model system used to simulate the effects from climate changes on a glacier named Grab鈕en at the Folgefonni ice cap in Western Norway is presented. One part of the system calculates the annual net balance of the glacier

from input of air temperature and precipitation data from Bergen; the other part simulates the physical conditions of the ice-masses and the advance or retreat of the glacier front. Four scenarios of climate changes are tested, two of which give as a result an advancing glacier after year 2002, while the two others gave a retreating glacier. The simulations show that the glacier is sensitive to changes in the precipitation pattern in the fall. (See also W90-08565) (Author's abstract)
W90-08591

CLIMATE VARIATION AND ICE CONDITIONS IN THE RIVER TORNEALVEN.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
G. Zachrisson.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 353-364, 7 fig, 5 ref.

Descriptors: *Finland, *Global warming, *Ice breakup, *River flow, *Sweden, *Tornealven River, Dams, Land use, Seasonal variation, Temperature, Water level, Weather.

The River Tornealven, between Finland and Sweden, has been subject to disastrous ice break-ups several times in the past, the interval being 10-20 years. During the 1980's three consecutive years have met with very severe break-ups; 1984, 1985, and 1986. A project was started aimed at measures to diminish the damages from such events. Break-up has occurred much earlier during the 20th century than in older times (observation are available from 1693). Comparisons with air temperature from 1860 and onwards indicate some agreement between earlier dates of break-up and the general temperature rise up to about 1940. The winter temperature seems to be of minor importance compared to the temperature in April. The severe break-ups are found to be associated primarily with a rapid increase in water level. During the years with ice problems in the 1980's, the water level increase was extremely large. This could be the effect of meteorological factors ('sudden' spring warming), but also changes within the catchment area (more intense forestry and removal of regulation dams in the tributaries) could have a hastening effect on the spring flood. However, a calculation of the relative importance of the different factors in contributing to the severe break-ups is difficult to make. (See also W90-08565) (Author's abstract)
W90-08592

2D. Evaporation and Transpiration

WINTER EVAPORATION ON A MOUNTAIN SLOPE, HAWAII.
Hawaii Univ., Honolulu. Dept. of Geography.
D. Nullet, and T. W. Giambelluca.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/4, p 257-265, January 1990. 2 fig, 2 tab, 15 ref.

Descriptors: *Evaporation, *Hawaii, *Model studies, Elevation, Heat advection, Mountains, Seasonal variation, Trade wind inversion.

Evaporation measurements at six sites on the island mountain, Haleakala, Hawaii were conducted between late November, 1987 and early January, 1988. Measurements were compared with estimated evaporation using four models to determine the applicability of the models to tropical islands and to identify possible sources of error in model estimates. All four models tested underestimated evaporation at all sites. Positive heat advection from the surrounding ocean and from land sources increased evaporation at low elevations while mixing of dry air through the trade wind inversion greatly increased evaporation at the highest elevation. (Author's abstract)
W90-07725

EFFECT OF WEATHER VARIABILITY ON THE ENERGY BALANCE OF A LAKE IN THE HUDSON BAY LOWLANDS, CANADA.
York Univ., North York (Ontario). Dept. of Geog-

raphy.
R. Bello, and J. D. Smith.
Arctic and Alpine Research ATLPAV, Vol. 22, No. 1, p 98-107, February 1990. 4 fig, 1 tab, 23 ref.

Descriptors: *Energy, *Lake evaporation, *Lakes, Advection, Canada, Evaporation, Latent heat, Mathematical studies.

Evaporation is an important component of the water balance of lakes in the Hudson Bay Lowlands, but the amount of summer evaporation in this area is not well known. Hourly summertime estimates of evaporation, from a small tundra lake near Churchill, Manitoba, are compared to equilibrium evaporation estimates of the Penman model. For the entire measurement period the Priestley-Taylor evaporability factor alpha equals 1.35. For individual days alpha ranges from 1.0 to 2.0 and for individual hours from 1.0 to 4.0. Local advection is primarily responsible for the large fluxes of latent heat. The latent heat flux exceeds available radiant energy over the summer, with temperature inversions occurring over the lake on the majority of days. The advective enhancement of lake evaporation responds to daily weather variations. The classification of these variations will improve operational estimates of lake evaporation. (Author's abstract)
W90-07875

DISTRIBUTION OF DEUTERIUM AND OXYGEN-18 DURING UNSTEADY EVAPORATION FROM A DRY SOIL.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
C. J. Barnes, and G. R. Walker.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 55-67, December 1989. 3 fig, 19 ref.

Descriptors: *Air-earth interfaces, *Deuterium, *Evaporation, *Isotope studies, *Model studies, *Oxygen isotopes, *Soil moisture deficiency, *Soil water, *Stable isotopes, Boundary conditions, Chlorides, Distribution patterns, Groundwater movement, Isotherms, Moisture content, Numerical analysis, Water vapor.

Evaporation from a dry soil was studied by modeling the movement and distribution of the stable isotopic species of water under transient isothermal conditions. This model extends an earlier steady-state model to account for unsteady evaporation. It was shown that with appropriate initial and boundary conditions, isotope profiles in space and time can be described in the same way as the water content profiles in terms of a similarity variable, proportional to depth and the inverse of time squared. The analysis provides a means for experimental examination of the detailed processes of evaporation, allowing quantitative partitioning of the evaporative flux between vapor and liquid movement at all points within a one-dimensional column. Isotope and chloride distributions were analyzed numerically for a step-function water content distribution, and compared with steady state profiles calculated for similar conditions. It was shown that whereas for steady state the peak isotope ratios are determined by atmospheric and deep soil isotope ratios, for these transient conditions the peak value depends also on water content, and may be higher or lower than for steady state. For very dry soils, decreasing water content leads to deeper, broader but lower isotope maxima. (Author's abstract)
W90-08217

TEMPERATURE GRADIENT EFFECTS ON STABLE ISOTOPE AND CHLORIDE PROFILES IN DRY SOILS.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
For primary bibliographic entry see Field 2G.
W90-08218

HOURLY ET MODEL CALIBRATION WITH EDDY FLUX AND ENERGY BALANCE DATA.

Group 2D—Evaporation and Transpiration

Oklahoma State Univ., Stillwater. Dept. of Agricultural Engineering.
M. A. Kizer, R. L. Elliott, and J. F. Stone.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 2, p 172-181, March/April 1990. 5 fig, 1 tab, 16 ref.

Descriptors: *Evapotranspiration, *Hydrologic budget, *Irrigation engineering, *Irrigation requirements, Air temperature, Alfalfa, Anemometers, Calibrations, Climatic data, Energy, Estimating equations, Heat balance, Net radiation, Rainfall, Root zone, Soil water, Solar radiation, Thermocouples.

A water budget of the crop root zone is often used in making irrigation scheduling decisions. With this approach, irrigation and rainfall represent the primary additions to soil water, and evapotranspiration (ET) is the major process removing water from the root zone. The Penman equation for estimating hourly ET of an alfalfa reference crop was calibrated for both daytime and nighttime conditions. Hourly net radiation, sensible heat flux, and soil heat flux were measured in the field for 16 24-hour periods, and evaporative flux was determined as the residual of the surface energy balance equation. The sensible heat flux measurements were made using a portable eddy correlation system that included a sonic anemometer and a fine-wire thermocouple. Following calibration, the hourly Penman model was applied to independent weather data from two growing seasons. Since only conventional weather parameters were measured during these two seasons, empirical equations were first developed to relate net radiation to solar radiation, and soil heat flux to solar radiation and air temperature. The resulting hourly ET estimates were summed over two-day to four-day intervals and compared to ET data obtained from soil water balance measurements. Good agreement was found between estimated and measured values. (Author's abstract)
W90-08355

SIMULATION OF THE IMPACT OF CO2 ATMOSPHERIC DOUBLING ON PRECIPITATION AND EVAPOTRANSPIRATION--STUDY OF THE SENSITIVITY TO VARIOUS HYPOTHESIS.
Institut Royal Meteorologique de Belgique, Brussels. Hydrology Section.
For primary bibliographic entry see Field 2B.
W90-08568

DETERMINATION OF AREAL EVAPOTRANSPIRATION FROM SATELLITE DATA USING A TEMPERATURE/SURFACE FLUXES INVERSION MODEL.
National Board of Waters, Helsinki (Finland).
For primary bibliographic entry see Field 7B.
W90-08576

POSSIBLE CHANGES IN FOREST HYDROLOGY FOLLOWING A GLOBAL CLIMATIC CHANGE.
Groningen Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
For primary bibliographic entry see Field 2I.
W90-08578

SENSITIVITY OF EVAPOTRANSPIRATION AND SOIL MOISTURE TO POSSIBLE CLIMATIC CHANGES.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
L. S. Kluchment, Y. G. Motovilov, and Z. P. Startseva.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 236-251, 2 fig, 2 tab, 3 ref.

Descriptors: *Climatic changes, *Evapotranspiration, *Global warming, *Greenhouse effect, *Soil water, Carbon dioxide, Model studies, Runoff, Soil moisture, Stomatal regulation, Wheat.

In estimating possible influence of CO2-induced changes in the climatic system on water resources

special attention is paid to the influence of atmospheric warming. However, the direct impact of the increase in atmospheric CO2 content on transpiration can play an important role. A physically based model of moisture transfer in the system 'soil--canopy--atmosphere' is used to estimate CO2-induced changes in evapotranspirations for wheat. The model takes into account not only variations of atmosphere and vegetation characteristics, but also various mutual non-linear effects of heat and moisture transfer in soil and plants caused by these variations. The analysis of seasonal dynamics of evapotranspiration shows that the greatest differences for various scenarios are observed in the phase of wheat active growth (blossoming, earing) when evapotranspiration is maximum. In the initial phase and in the phase of ripening these differences are not so appreciable. Comparison of the results shows that the use of simplified models, taking into account only meteorological characteristics and neglecting mechanisms of plants' stomatal regulation can lead to inaccurate conclusions and results in estimating the impact of the greenhouse effect on evapotranspiration and river runoff. In this case it can be concluded that evapotranspiration grows as a result of the increase in atmospheric CO2 content, and therefore, river runoff diminishes. (See also W90-08565) (White-Reimer-PTT)
W90-08582

LANDSCAPE INFLUENCE ON LAND-ATMOSPHERE HEAT MOISTURE EXCHANGE AND ITS VARIABILITY.
Gosudarstvennyi Gidrologicheskii Inst., Valdai (USSR).
A. A. Kapotov, and P. A. Kolosov.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 281-292, 5 fig, 1 tab.

Descriptors: *Climates, *Evaporation, *Humidity, *Land use, Fluctuations, Moisture transfer, Vegetation.

The landscape climate forming effect is studied for four types of landscape: a forest; field catchments; a meadow; and a winter crop field. The landscapes influence on the time-spatial distribution of the heat moisture exchange in the land-atmosphere system is considered the climate forming effect. The between-year fluctuations of monthly averaged values of heat-water flux were used in the evaluation. The long-term data analysis showed landscape has a significant influence on the formation of the land-atmosphere interaction process. Vegetation was found to have the maximum capability for transforming 'input humidification'--precipitation. Maximum differences in the moisture transferring characteristic and the degree of attenuation occur between forests and anthropogenic landscapes with the latter having the least capability to attenuate and the least sustaining power to climate fluctuation. (See also W90-08565) (Author's abstract)
W90-08586

2E. Streamflow and Runoff

RIVER ECOSYSTEMS: ECOLOGICAL CONCEPTS AND DYNAMICS.
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
For primary bibliographic entry see Field 2H.
W90-07523

MORPHOLOGICAL AND HYDROLOGICAL CHARACTERISTICS OF SOME ALLOCHTHONOUS RIVER CHANNELS, WESTERN DECCAN TRAP UPLAND REGION, INDIA.
Poona Univ. (India). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-07571

LATE CENOZOIC EVOLUTION OF THE TUOLUMNE RIVER, CENTRAL SIERRA NEVADA, CALIFORNIA.

Geological Survey, Menlo Park, CA.
N. K. Huber.
Geological Society of America Bulletin BUGMAF, Vol. 102, No. 1, p 102-115, January 1990. 11 fig, 26 ref.

Descriptors: *Cenozoic era, *Channel erosion, *Geologic history, *Geomorphology, *Incised rivers, *Tuolumne River, California, Glaciation, River channels, Volcanoes.

Many studies have demonstrated that the Sierra Nevada was uplifted during the late Cenozoic to form the present range. The Tuolumne River is the northernmost of the major rivers draining the west slope of the Sierra Nevada whose course was not totally disrupted by volcanism. Erosional remnants of volcanic rock deposited in a 10 million year old channel of the river permit its partial reconstruction. Uplift during the past 10 million year is estimated to be as much as 1,830 m at Tioga Pass. An ancestral range of hills occupied the present site of the Sierra crest 10 million year ago, forming a barrier to western drainage. The evolution of the Tuolumne River has resulted in as much as 1,525 m of new channel incision during the last 10 million year, and the modern channel is about 915 m lower than the abandoned ancient channel. An undetermined amount of this downcutting was from glacial erosion. (Tappert-PTT)
W90-07597

ADVANCES IN FLUVIAL GEOMORPHOLOGY OF MOUNTAIN ENVIRONMENTS.
Instituto Pirenaico de Ecologia, Jaca (Spain).
For primary bibliographic entry see Field 2J.
W90-07632

HYDROLOGIC SIMILARITY 3. A DIMENSIONLESS FLOOD FREQUENCY MODEL USING A GENERALIZED GEOMORPHOLOGIC UNIT HYDROGRAPH AND PARTIAL AREA RUNOFF GENERATION.
Princeton Univ., NJ. Water Resources Program.
M. Sivapalan, E. F. Wood, and K. J. Beven.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 43-58, January 1990. 15 fig, 22 ref, 4 append. NASA Grants NAG-5-491, NAG-1392, and USGS Grant 14-08-0001-G1138.

Descriptors: *Flood forecasting, *Flood frequency, *Geomorphology, *Hydrographs, *Mathematical models, *Model studies, *Rainfall-runoff relationships, *Runoff, *Runoff forecasting, Statistical analysis, Storm runoff.

One of the shortcomings of the original theory of the geomorphologic unit hydrograph (GUH) is that it assumes that runoff is generated uniformly from the entire catchment area. It is now recognized that in many catchments much of the runoff during storm events is produced on partial areas which usually form on narrow bands along the stream network. A storm response model that includes runoff generation on partial areas by both Hortonian and Dunne mechanisms was recently developed. Integrating the partial runoff generation model with the GUH-based runoff routing model leads to a generalized GUH. The generalized GUH and the storm response model are then used to estimate physically based flood frequency distributions. In most previous work the initial moisture state of the catchment had been assumed to be constant for all the storms. When this assumption is relaxed and the initial moisture conditions allowed to vary between storms, the resulting flood frequency distributions are cast in a scaled dimensionless framework where issues such as catchment scale and similarity can be conveniently addressed. A number of experiments are performed to study the sensitivity of the flood frequency response to some of the 'similarity' parameters identified in this formulation. The results indicate that one of the most important components of the derived flood frequency model relates to the specification of processes within the runoff generation model; specifically the inclusion of both saturation excess (Dunne) and Horton infiltration excess runoff production mechanisms. The dominance of these mechanisms over different return periods of

the flood frequency distribution can significantly affect the distributional shape and confidence limits about the distribution. Comparisons with observed flood distributions seem to indicate that such mixed runoff production mechanisms influence flood distribution shape. The sensitivity analysis also indicated that the incorporation of basin and rainfall storm scale also greatly influences the distributional shape of the flood frequency curve. (Author's abstract)
W90-07638

HYDROLOGIC SENSITIVITIES OF THE SACRAMENTO-SAN JOAQUIN RIVER BASIN, CALIFORNIA, TO GLOBAL WARMING.
Washington Univ., Seattle. Dept. of Civil Engineering.
D. P. Lettenmaier, and T. Y. Gan.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 69-86, January 1990. 15 fig, 11 tab, 28 ref.
USEPA Cooperative Agreement CR814637.

Descriptors: *California, *Climatology, *Global warming, *Greenhouse effect, *Model studies, *Snowmelt, *Streamflow, *Streamflow forecasting, Evapotranspiration, Future planning, Sensitivity analysis, Snow accumulation, Stream discharge, Stream gages, Streamflow data, Weather forecasting.

The recent advent of climate simulations using physically based general circulation models (GCMs) provides a method of generating future climate scenarios to evaluate the reliability of surface water resources. Using GCMs, the hydrologic sensitivities of four medium-sized mountainous catchments in the Sacramento and San Joaquin river basins to long-term global warming were analyzed. The study catchments were selected to represent the geographic, climatic, and hydrologic diversity of the Sacramento-San Joaquin River basin. In addition, the following selection criteria were used: (1) diversions and storage upstream of the gaging station should be minimal; (2) the stream gage should be rated 'good' or better, with the record including the years 1951-1980; and (3) the annual runoff should be highly correlated with the summed annual inflows to the reservoir system. The hydrologic response of these catchments, all of which are dominated by spring snowmelt runoff, were simulated by the coupling of the snowmelt and the soil moisture accounting models of the U.S. National Weather Service River Forecast System. In all four catchments the global warming pattern, which was indexed to CO2 doubling scenarios simulated by three (global) general circulation models, produced a major seasonal shift in the snow accumulation pattern. Under the alternative climate scenarios more winter precipitation fell as rain instead of snow, and winter runoff increased while spring snowmelt runoff decreased. In addition, large increases in the annual flood maxima were simulated, primarily due to an increase in rain-on-snow events, with the time of occurrence of many large floods shifting from spring to winter. (Tappert-PTT)
W90-07640

STATISTICAL LOG PIECEWISE LINEAR MODEL OF AT-A-STATION HYDRAULIC GEOMETRY.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
B. C. Bates.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 109-118, January 1990. 3 fig, 6 tab, 33 ref.

Descriptors: *Hydraulic geometry, *Mathematical models, *Model studies, *Runoff forecasting, *Stream profiles, Statistical methods, Stream gages.

The concept of hydraulic geometry has been used extensively to describe the behavior of natural river flows in a variety of physiographic and climatic regimes. A new log piecewise linear model of at-a-station hydraulic geometry and a statistical methodology for fitting the model to observed data are compared to several existing models. The proposed parameterization provides a continuity

relationship between the model parameters and allows the model to reduce to the Leopold and Maddock power function model when one of the parameters is set equal to zero. Applications of the new model, the Leopold and Maddock model, and the Richards log quadratic model are made to 22 gauging stations in New South Wales, Australia. Ordinary least squares (OLS) procedures are used to fit the models to the data. Results indicate that the new model is superior to the existing models in that it allows the identification of the points at which there are breaks in the slopes of the width-, mean depth-, and mean velocity-discharge relations. In addition, it often produces smaller residual variances and residuals that more frequently conform with the OLS error assumptions. However, more sophisticated procedures for parameter estimation may be needed in some instances if statistical inferences are to be drawn from these regression models. (Author's abstract)
W90-07643

EFFECTS OF MULTIPLE DISTURBANCE ON MACROINVERTEBRATE COMMUNITIES IN THE ACHERON RIVER, VICTORIA.
Monash Univ., Clayton (Australia). Centre for Stream Ecology.
P. S. Lake, T. J. Doeg, and R. Marchant.
Australian Journal of Ecology AJECDQ, Vol. 14, No. 4, p 507-514, December 1989. 3 fig, 3 tab, 26 ref. Australian Water Research Advisory Council Grant No. 85/3.

Descriptors: *Australia, *Macroinvertebrates, *Population density, *Riffles, *Species diversity, *Stream biota, Acheron River, Aquatic life, Aquatic populations, Population dynamics, Streams.

In the Acheron River, southern Victoria, Australia, patches of riffle substratum (approximately 1 square m) were disturbed every 10 days by kicking and raking. After 20 days (three disturbances) a further set of patches was disturbed once. For the next 70 days macroinvertebrate dynamics were monitored in the two sets of disturbed patches and also in contiguous control patches. There were no differences in the temporal changes in total species richness, number of species per sample, densities of individuals, or species diversity between the two disturbance regimes. The composition of the fauna colonizing each disturbance regime was similar, and after 33 days the number of species per sample was similar in disturbed and control patches. The fauna appears to be well adapted to physical disturbance and current ideas linking species richness and disturbance cannot be readily applied to stream communities at the temporal and spatial scales of this experiment. (Author's abstract)
W90-07648

ASYMPTOTIC EXPANSION FOR STEADY STATE OVERLAND FLOW.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
J. Y. Parlange, W. Hogarth, G. Sander, C. Rose, and R. Haverkamp.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 579-583, April 1990. 4 fig, 1 tab, 6 ref.

Descriptors: *Hydrologic models, *Overland flow, *Rainfall-runoff relationships, *St Venant equation, Diffusion models, Kinematic models, Kinematic wave theory.

The full Saint Venant equations of overland flow on a plane are often replaced by simpler models. The errors in the kinematic and the diffusion models are estimated by comparing their predictions with the exact numerical solution of the Saint Venant equations under steady state conditions. It is shown that the two approximate models can have significant errors even for critical flow and fairly large kinematic wave numbers. When the kinematic approximation is inaccurate, the improvement of the diffusion approximation seems modest. For the same level of mathematical complexity as the diffusion approximation, a far more accurate approximation is proposed when the kinematic wave number is large. It is then possible to

split the solution of the Saint Venant equation in two regions, one near the downstream end of the plane and the other covering most of the plane. (Author's abstract)
W90-07668

BIOCHEMICAL OXYGEN DEMAND AND ALGAE: FRACTIONATION OF PHYTOPLANKTON AND NONPHYTOPLANKTON RESPIRATION IN A LARGE RIVER.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
For primary bibliographic entry see Field 2H.
W90-07675

INSTABILITY OF HYDRAULIC GEOMETRY.
East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
For primary bibliographic entry see Field 2J.
W90-07681

LONG-TERM INVESTIGATIONS OF TROPHIC RELATIONSHIPS IN SOUTHERN CHALK STREAMS.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
For primary bibliographic entry see Field 2H.
W90-07715

NETWORK FOR LONG-TERM ECOLOGICAL RESEARCH IN THE UNITED STATES.
Wisconsin Univ.-Madison. Center for Limnology.
For primary bibliographic entry see Field 2H.
W90-07716

INFLUENCE OF WOODY DEBRIS ON NUTRIENT RETENTION IN CATASTROPHICALLY DISTURBED STREAMS.
Mississippi Univ., University. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-07718

EXPERT SYSTEM FOR THE SELECTION OF A SUITABLE METHOD FOR FLOW MEASUREMENT IN OPEN CHANNELS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
S. P. Simonivic.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/4, p 237-256, January 1990. 1 fig, 1 tab, 20 ref.

Descriptors: *Data acquisition, *Expert systems, *Flow measurement, *Open channels, *Stream gages, Equipment, Measuring instruments.

The science of stream gaging has evolved through the years, mainly from the experiences and innovations of its practitioners. Stream-gaging procedures are standardized on the national and international level. However, the selection of a suitable method for flow measurement is still a fairly complex process. The knowledge-based system presented was designed to aid the user in the selection process. Two aspects of selection are considered: physical characteristics of the gaging site and available equipment and/or structures at the gaging site. The system has been designed for the potential use in Environment Canada. The SFM and STR systems were developed as potential modules for incorporation into an intelligent decision support system (IDSS) considered for supporting the operation of the existing network of gaging stations operated by Environment Canada. The expert systems technology is presented as one of the tools with the potential for application in IDSS development. The results indicate that for well-defined problems like surface flow measurement method selection, expert system technology may be used to improve the operation, provide rational solutions and provide a useful training tool. (Author's abstract)
W90-07724

Group 2E—Streamflow and Runoff

AUTOMATIC CASCADE NUMBERING OF UNIT ELEMENTS IN DISTRIBUTED HYDROLOGICAL MODELS.
Universidad Autonoma Chapingo (Mexico). Dept. de Suelos.
For primary bibliographic entry see Field 7C.
W90-07731

SCHEDULING MAINTENANCE DREDGING ON A SINGLE REACH WITH UNCERTAINTY.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-07734

HYDROCHEMISTRY AND PHYTOPLANKTON OF A MAJOR BLACKWATER RIVER (CARONI) AND A HYDROELECTRIC RESERVOIR (MACAGUA), VENEZUELA.
Fundacion La Salle de Ciencias Naturales, San Felix (Venezuela). Estacion Hidrobiologica de Guayana.
For primary bibliographic entry see Field 2H.
W90-07737

STUDY OF THE METAL CONTENT IIN THE WATERS OF THE PROTECTED REGION OF THE JUZERA MOUNTAINS.
Ceske Vysoke Uceni Technicke v Praze. Faculty of Civil Engineering.
For primary bibliographic entry see Field 5C.
W90-07741

PHYTOPLANKTON OF RESERVOIRS IN RELATION TO THE TROPHIC POTENTIAL OF INFLOW WATER.
Vyzkumny Ustav Vodohospodarsky, Brno (Czechoslovakia).
Z. Zakova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 373-376, 1989. 1 fig, 2 tab, 3 ref.

Descriptors: *Bioassay, *Czechoslovakia, *Eutrophication, *Influent streams, *Phytoplankton, *Pollution index, *Reservoirs, *Trophic level, Algae, Culturing techniques, Fishkill, Nutrients, Sample preparation, Scenedesmus, Uniform Methods of the Council of Mutual, Water analysis, Water pollution, Water pollution effects, Water quality, Water quality trends.

Human activities within reservoir catchments affect nutrient levels in the inflow waters and accelerate eutrophication of the reservoirs, which is mainly manifested by the increasing development of phytoplankton. The eutrophication entails deterioration of water quality and problems in water treatment when used for water supplies and industries. It may involve mortality of fish by oxygen deficiencies, and some secondary contamination after the decay of algae. In order to review and evaluate the trophic state of rivers a method of determination of the trophic potential of water was developed and verified during may years of practical use. This method is a form of bioassay based on evaluation of water quality, as trophic potential, in accordance with the reactions or vital activities of organisms. Conditions of the test were standardized in cooperation with many specialists from different laboratories in Czechoslovakia. The method was incorporated into the Uniform Methods of the Council of Mutual Economic Aid. The trophic potential of water is an index of biologically usable nutrients in water. The determination is based on a laboratory batch cultivation of the alga Scenedesmus quadricauda, strain Greifswald/15, in water samples under standard cultivation conditions. The water samples were filtered within 24 hours of collection to eliminate the original seston. The cultivation was performed in a culture apparatus with water-bath controlled temperature and constant irradiance. Mixing was done by compressed air saturated with 1.0 % by volume of CO2. (Mertz-PTT)
W90-07746

PHYTOPLANKTON OF THE RADUNIA RIVER IN A CASCADE OF SMALL RESERVOIRS.
Research Inst. of Environmental Development, Poznan (Poland).
For primary bibliographic entry see Field 2H.
W90-07748

FATE OF ZOOPLANKTON IN A RIVER AFTER LEAVING A DAM RESERVOIR.
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
For primary bibliographic entry see Field 2H.
W90-07764

DRIFT OF AQUATIC INSECTS FOLLOWING METHOXYCHLOR TREATMENT OF THE SASKACHEWAN RIVER SYSTEM.
Saskatchewan Univ., Saskatoon. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-07820

DIVIDING FLOW IN OPEN CHANNELS.
Concordia Univ., Sir George Williams Campus, Montreal (Quebec).
For primary bibliographic entry see Field 8B.
W90-07837

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MONTANA, OCTOBER 1987 THROUGH SEPTEMBER 1989.
Geological Survey, Helena, MT. Water Resources Div.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-591, 1990. 78p, 10 fig, 4 tab.

Descriptors: *Data collections, *Groundwater, *Hydrology, *Montana, *Surface water, *Water resources data, Streamflow, Water quality, Water wells.

Water resources programs and activities of the U.S. Geological Survey in Montana consist principally of hydrological data collection and local, areal, or statewide hydrologic investigations. The work is supported by direct Federal funding, by transfer of funds from other Federal agencies, and by joint funding agreements with State or local agencies. The Montana District of the Geological Survey's Water Resources Division conducts its hydrologic work through a headquarters office in Helena, and field offices in Helena, Billings, Fort Peck and Kalispell. This report describes the eighteen projects funded for fiscal years 1988 and 1989. In addition, it describes the operations of the Montana District, water conditions during water year 1988, activities in addition to regular programs, sources of publications and information, and lists reports published or released during the preceding 5 years. (USGS)
W90-07838

TECHNIQUES FOR SIMULATING FLOOD HYDROGRAPHS AND ESTIMATING FLOOD VOLUMES FOR UNGAGED BASINS IN EAST AND WEST TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
C. R. Gamble.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4076, February 1990. 40p, 14 fig, 8 tab, 10 ref.

Descriptors: *Flood forecasting, *Flood hydrographs, *Flood peak, *Hydrograph analysis, *Tennessee, Flood-control storage, Lagtime, Streamflow forecasting.

A dimensionless hydrograph developed for a variety of basin conditions in Georgia was tested for its applicability to streams in East and West Tennessee by comparing it to a similar dimensionless hydrograph developed for streams in East and West Tennessee. Hydrographs of observed discharge at 83 streams in East Tennessee and 38 in West Tennessee were used in the study. Statistical analyses were performed by comparing simulated (or computed) hydrographs, derived by application of the Georgia dimensionless hydrograph, and dimensionless hydrographs developed from Tennessee data, with the observed hydrographs at 50 and 75% of their peak-flow widths. Results of the tests indicate that the Georgia dimensionless hydrography is virtually the same as the one developed for streams in East Tennessee, but that it is different from the dimensionless hydrograph developed for streams in West Tennessee. Because of the extensive testing of the Georgia dimensionless hydrograph, it was determined to be applicable for East Tennessee, whereas the dimensionless hydrograph developed from data on streams in West Tennessee was determined to be applicable in West Tennessee. As part of the dimensionless hydrograph development, an average lagtime in hours for each study basin, and the volume in inches of flood runoff for each flood event were computed. By use of multiple-regression analysis, equations were developed that relate basin lagtime to drainage area size, basin length, and percent impervious area. Similarly, flood volumes were related to drainage area size, peak discharge, and basin lagtime. These equations, along with the appropriate dimensionless hydrograph, can be used to estimate a typical (average) flood hydrograph and volume for recurrence-intervals up to 100 years at any ungaged site draining less than 50 sq mi in East and West Tennessee. (USGS)
W90-07843

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1987. VOLUME 1, GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-07844

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1987. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-07845

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988, VOLUME 1. EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-07846

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1988, VOLUME 1. EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-07847

ESTIMATING FLOOD HYDROGRAPHS FOR ARKANSAS STREAMS.
Geological Survey, Little Rock, AR. Water Resources Div.
B. L. Neely.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4109, November 1989. 19p, 4 fig, 8 ref.

Descriptors: *Arkansas, *Discharge frequency, *Discharge hydrographs, *Flood data, *Flood peak, *Hydrograph analysis, Bridge design, Gaging stations, Runoff volume.

Flood hydrographs are needed for the design of many drainage structures and embankments. A method for determining these flood hydrographs at ungaged sites in Arkansas is presented. Dimensionless hydrographs can be used with lagtime (or equivalent lagtime as used in this study) and peak discharge to produce a typical hydrograph for streams in Arkansas with drainage areas less than 600 sq miles. A hydrograph-width relation is pre-

sented for those instances when it is only necessary to know the period of time that a specific discharge will be exceeded. Multiple regression analysis was used to define relations between equivalent lagtime and basin, climatic, and hydrologic characteristics. Data collected on 450 storms at 49 gaging stations were used in the analysis. The regression analysis indicated that drainage area and 100-year discharge are significant parameters for estimating equivalent lagtime. A method is presented for computing the volume of runoff for a flood when the peak discharge and equivalent lagtime are known. (USGS)
W90-07855

MISCELLANEOUS STREAMFLOW MEASUREMENTS IN THE STATE OF WASHINGTON, JANUARY 1961 TO SEPTEMBER 1985.
Geological Survey, Tacoma, WA. Water Resources Div.
J. R. Williams, and S. A. Riis.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-380, 1989. 382p, 2 tab, 3 ref.

Descriptors: *Data collections, *Stream discharge, *Streamflow, *Washington, *Water resources data, Drainage area, Streams.

This report is a compilation of previously published miscellaneous streamflow measurements made in Washington State by the U.S. Geological Survey between January 1961 and September 1985. It is a supplement to a volume of similar data for the period 1890 to January 1961. The data include stream name and stream to which it is tributary, latitude and longitude, county code, hydrologic unit code, land-line location, drainage area, and measurement dates and discharges. In general, the data sites are not at gaging stations; however, some data are given for gaging station sites during periods when the stations were not in operation. All data in this report have been entered into a computerized data base that includes the data for the period 1890 to January 1961. The data can be retrieved in a variety of ways, such as by county, by hydrologic unit code, by river basin, or by size of drainage area. (USGS)
W90-07858

STREAMFLOW STATISTICS FOR STREAMS ON THE PUYALLUP INDIAN RESERVATION, WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
D. L. Kresch, and E. A. Prych.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4228, 1989. 34p, 1 pl, 1 fig, 18 tab, 10 ref.

Descriptors: *Puyallup Indian Reservation, *Stream discharge, *Streamflow, *Washington, *Water resources data, Correlation analysis, Puget Sound, Regional analysis, Regression analysis, Streamflow statistics.

Streamflow statistics consisting of low flows, high flows, mean monthly flows, mean annual flows, flow durations, and peak flows were estimated for 16 sites on small streams on the Puyallup Indian Reservation, Washington. Drainage areas ranged from 0.62 to 16.7 sq mi. Streamflow statistics were also computed for the Puyallup River at Puyallup (gaging station 12101500). All of the small-stream statistics except for the peak flows were estimated by using station regression equations to transfer streamflow statistics for long-term gaging stations to the small-stream sites. An equation for each small-stream site was developed by regressing approximately 12 monthly measurements of discharge at that site with respect to concurrent daily mean discharges at a long-term gaging station. The coefficients of correlation between the discharges range from 0.98 to 0.79 except for one value of 0.58. Peak flows for the small-stream sites were estimated by use of regional regression equations. The regional regression equations, which express the statistics as functions of drainage area and mean annual precipitation, were developed using data for 26 gaging stations in the Puget Sound area. (USGS)

W90-07860

SUMMARY OF DATA PERTAINING TO LAND USE, RAINFALL, DRYFALL, STREAM DISCHARGE, AND STORM RUNOFF COLLECTED AS PART OF A STUDY OF THE EFFECTS OF URBAN RUNOFF ON RAPID CREEK, RAPID CITY AREA, SOUTH DAKOTA.
Geological Survey, Rapid City, SD. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-07862

MONITORING FLORIDA'S RIVERINE FISH COMMUNITIES.
Florida Game and Fresh Water Fish Commission, Holt. Blackwater Fisheries Research and Development Center.
For primary bibliographic entry see Field 8I.
W90-07876

NONPOINT SOURCE PHOSPHORUS CONTROL BY A COMBINATION WET DETENTION/FILTRATION FACILITY IN KISSIMMEE, FLORIDA.
Smith and Gillespie Engineers, Inc., Sarasota, FL.
For primary bibliographic entry see Field 5G.
W90-07877

COMPOSITION AND DYNAMICS OF A HIGHLY DIVERSE DIATOM ASSEMBLAGE IN A LIMESTONE STREAM.
Dept. d'Ecologia, Avgda. Diagonal 645, 08028 Barcelona, Spain.
For primary bibliographic entry see Field 2H.
W90-07880

VERTICAL AND LATERAL DISTRIBUTION OF FINE-GRAINED PARTICULATES IN PRAIRIE AND CORDILLERAN RIVERS: SAMPLING IMPLICATIONS FOR WATER QUALITY PROGRAMS.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-07911

ELIMINATION OF LONG LIVED FISSION PRODUCTS FROM RIVER SEDIMENT.
Novi Sad Univ. (Yugoslavia). Inst. of Physics.
For primary bibliographic entry see Field 5B.
W90-07915

EVALUATION OF SOME METHODS OF DETERMINING STORAGE YIELD RELATIONSHIPS FOR IMPOUNDING RESERVOIRS.
Hanley (Ryan) and Co., Galway (Ireland).
For primary bibliographic entry see Field 6B.
W90-07931

FLOOD FREQUENCY ANALYSIS FOR THE 1988 TRURO FLOODS.
Institute of Hydrology, Wallingford (England).
M. C. Acreman, and R. J. Horrocks.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 62-69, February 1990. 3 fig, 6 tab, 17 ref.

Descriptors: *England, *Flood forecasting, *Flood frequency, *Floods, Data interpretation, Data processing, Historic floods.

In January 1988, the city of Truro experienced a severe flood from the River Kenwyn. The return period of this event was initially estimated at 350 years using the methodology recommended in the Flood Studies Report, and fitting the extreme value type 1 distribution to the annual maximum flood series. Regional growth factors should be applied for greater return periods. In October of the same year, a second flood, of even greater magnitude, occurred. The subsequent investigations employed a variety of flood frequency estimation techniques including one which uses descriptive information of the history of flooding,

obtained from local newspapers and journals, in addition to recent flow records. The return periods of the two events were reassessed to be 50 and 100 years respectively. This flood frequency behavior was found to be markedly different from the regional average for the South West of England. (Author's abstract)
W90-07934

ORGANIC MATTER DEGRADATION AND NUTRIENT REGENERATION IN AUSTRALIAN FRESHWATERS: II. SPATIAL AND TEMPORAL VARIATION, AND RELATION WITH ENVIRONMENTAL CONDITIONS.
Murray-Darling Freshwater Research Centre, Albury (Australia).
P. I. Boon.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 4, p 405-436, February 1990. 7 fig, 7 tab, 52 ref.

Descriptors: *Cycling nutrients, *Degradation, *Enzymes, *Freshwater, *Nutrients, *Organic matter, Algae, Ammonium, Aquatic bacteria, Australia, Chlorophyll a, Lakes, Rivers, Seasonal variation, Spatial distribution, Temporal distribution.

Rates of exoenzyme activity in the water column of 17 sites in the Murray-Darling Basin were determined over a one-year period. The most active exoenzyme was aminopeptidase, followed by alkaline phosphatase, lipase, N-acetyl beta-D-glucoaminidase, alpha-D-glucosidase and beta-D-glucosidase, beta-D-galactosidase and endopeptidase. Exoenzyme activity in rivers (alkaline phosphatase, 0.9-8.2 micromoles/L/day; aminopeptidase, 3.5-32 micromoles/L/day) was within the range reported for Northern-Hemisphere systems, but activity in billabongs (alkaline phosphatase, 4.4-222 micromoles/L/day; aminopeptidase, 8.7-1134 micromoles/L/day) was generally higher than that in rivers and other previously studied systems. Strong relationships were detected between aminopeptidase activity, chlorophyll-a concentrations, bacterial numbers and concentrations of ammonium and dissolved primary amines in the billabong. These interactions were not evident in the river. There were few clear relationships between alkaline phosphatase activity and environmental conditions in either billabong or river. (Author's abstract)
W90-07956

WATERSHED SCALE RAINFALL INTERCEPTION ON TWO FORESTED WATERSHEDS IN THE LUQUILLO MOUNTAINS OF PUERTO RICO.
Institute of Tropical Forestry, Rio Piedras, PR.
F. N. Scatena.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 89-102, February 1990. 2 fig, 3 tab, 31 ref. NSF Grant BSR-8811764.

Descriptors: *Forest watersheds, *Interception, *Throughfall, *Vegetation effects, Model studies, Monitoring, Stemflow.

Interception losses were monitored for one year and related to vegetation characteristics in two watersheds in the Luquillo Experimental Forest of Puerto Rico. Total watershed interception was then modeled by weighing values of throughfall measured in representative areas of different vegetation types by the total watershed area of that vegetation group. Annual canopy throughfall equaled 59% of annual rainfall whereas stemflow represented 2.3%. Canopy throughfall was greatest in gaps and along stream channel with 91% of the total falling over 75% of the watershed area. However, 50% of the total stemflow came from less than of the total stems. Reported values of throughfall in the Tabonuco type forest of the Luquillo Mountains are typically 20 to 30% less than values reported for many montane and lowland tropical forests. These differences result from a high frequency, low intensity rainfall rather than the physiognomic character of the forest. (Author's abstract)
W90-07979

Group 2E—Streamflow and Runoff

SALINITIES AND SEDIMENT TRANSPORT IN THE BOLIVIAN HIGHLANDS.
Office de la Recherche Scientifique et Technique Outre-Mer, La Paz (Bolivia).
For primary bibliographic entry see Field 2J.
W90-07983

MODELLING SNOWMELT IN A MOUNTAINOUS RIVER BASIN ON AN EVENT BASIS.
Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft.
For primary bibliographic entry see Field 2C.
W90-07987

STORM-RUNOFF GENERATION IN THE PERMANENTE CREEK DRAINAGE BASIN, WEST CENTRAL CALIFORNIA--AN EXAMPLE OF FLOOD-WAVE EFFECTS ON RUNOFF COMPOSITION.
Geological Survey, Menlo Park, CA.
K. M. Nolan, and B. R. Hill.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 343-367, February 1990. 10 fig, 4 tab, 38 ref.

Descriptors: *California, *Flood waves, *Geochemistry, *Rainfall-runoff relationships, *Storm runoff, *Tracers, Chemical composition, Flood hydrographs, Stream gages.

Variations in the isotopic and chemical composition of storm runoff in the 10.6 sq km Permanente Creek Basin, Santa Clara County, California, indicate that changes in water composition lag behind changes in streamflow. This lag occurs even though field observations and rainfall-runoff modeling indicate that much of the storm runoff is composed of 'new' water running off impervious surfaces. The apparent incompatibility posed by the presence of 'old' water and the direct and indirect evidence that surface runoff contributes substantially to storm runoff can be explained if initial rises in streamflow result from effects of flood waves. The presence of flood waves in storm runoff was verified by recording gage-height changes both at the Permanente Creek gaging station and at a site 600 m above the station. The timing of peak gage heights at these two sites was compatible with flood-wave velocities equal to about five-thirds mean stream velocity. Hydrograph separation based on chemical tracers seems more reliable during early phases of the storms than during later phases. Apparently, chemical reactions occurring within the channel break down the conservative nature of K, SiO2 and specific conductance during later phases. Rapid increases in SiO2 concentrations during rising stages are particularly difficult to explain unless changes in temperature, pH, and sediment availability affect SiO2 solubility. (Author's abstract)
W90-07994

PHYTOPLANKTON AND ZOOPLANKTON (CLADOCERA, COPEPODA) RELATIONSHIP IN THE EUTROPHICATED RIVER DANUBE (DANUBIALIA HUNGARICA, CXI).
Magyar Tudomanyos Akademia, Budapest. Station for Danube Research.
For primary bibliographic entry see Field 5C.
W90-08082

ACCOUNTING FOR DENSITY FRONT ENERGY LOSSES.
Contra Costa Water District, Concord, CA.
R. A. Denton.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 2, p 270-275, February 1990. 2 fig, 11 ref.

Descriptors: *Density currents, *Internal water, Boundary layers, Comparison studies, Cooling ponds, Density stratification, Energy conversion, Engineering, Estuaries, Geophysics, Hydraulic jump, Reservoirs, Velocity head, Water quality.

The propagation of density currents and internal bores is of considerable interest in engineering and geophysics. Flows of this type can occur in estuaries, reservoirs, cooling ponds, and the atmospheric boundary layer and play an important role in determining air and water quality. Three examples of two-dimensional density fronts are: (1) bottom density current; (2) internal bore; and (3) internal hydraulic jump. In all three examples, the two main dependent variables are the head velocity and the free surface defection; both are functions of the lower layer thickness behind the front, the layer densities, and either the upstream layer thickness or the nose height. Two equations are needed to solve for the two dependent variables. There is some question as to the validity of choosing an upper layer energy balance for internal bores. An alternative internal bore solution based on an upper layer energy balance has been obtained and compared with a previously-derived solution. The assumption that energy losses occur in the converging rather than diverging layer more accurately predicts the behavior of internal bores when the bore thickness is greater than the upstream layer thickness. No matter which layer is taken as energy conserving, the model predicts an energy loss in the other layer so neither case can be discounted as physically unrealistic. Although choosing energy conservation in the lower layer gives better agreement with the data than the comparison model, further research is needed to find physical reasons why this choice is better. (Fish-PTT)
W90-08213

FIELD STUDIES OF THE EFFECTS OF THE CAPILLARY FRINGE ON STREAMFLOW GENERATION.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 2F.
W90-08214

REGIONAL ANALYSIS OF STREAM SALINISATION IN SOUTHWEST WESTERN AUSTRALIA.
Water Authority of Western Australia, Perth.
For primary bibliographic entry see Field 5B.
W90-08215

HYDROGRAPH SEPARATION IN A SMALL ALPINE BASIN BASED ON INORGANIC SOLUTE CONCENTRATIONS.
Colorado Univ., Boulder. Inst. of Arctic and Alpine Research.
N. Caine.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 89-101, December 1989. 5 fig, 4 tab, 27 ref. National Science Foundation Long-Term Ecological Research Grant Nos. BSR 8514329 and BSR 8745637.

Descriptors: *Alpine regions, *Hydrograph analysis, *Mountain watersheds, *Snowmelt, *Surface-groundwater relations, *Water chemistry, Catchment basins, Colorado, Diurnal variation, Ions, Melting, Seasonal storage, Specific conductivity, Stream discharge, Subsurface water.

Snowmelt hydrographs for the eight-hectare Martinelli Basin on Niwot Ridge, Colorado Front Range, show a well-marked diurnal periodicity for much of the summer melt season. The discharges have been separated into ground-surface and subsurface components on the basis of the major ion concentrations and specific conductance of the streamwater. The results suggest a high (up to 50%) contribution by subsurface routing through the superficial mantle of the basin, even during the highest flows of the melt season. Both surface and subsurface components retain the diurnal pattern of the hydrograph, with the latter lagged by only about one hour. This suggests that even subsurface routing gives a quick hydrologic response from this basin. (Author's abstract)
W90-08219

STORM RUNOFF SIMULATION USING AN ANTECEDENT PRECIPITATION INDEX (API) MODEL.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
M. A. Fedora, and R. L. Beschta.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 121-133, December 1989. 6 fig, 4 tab, 16 ref.

Descriptors: *Antecedent precipitation index, *Model studies, *Rainfall-runoff relationships, *Runoff forecasting, *Simulation analysis, *Storm runoff, Error analysis, Flood hydrographs, Flood peak, Hydrographs, Hyetographs, Oregon, Performance evaluation, Recession curve, Regression analysis, Streamflow, Watersheds.

An antecedent precipitation index (API) model for predicting storm runoff was developed for use in the Oregon Coast Range. A coefficient K, derived from recession analysis of storm hydrographs, was used to decay over time the effects of antecedent precipitation upon runoff. Linear regression was then used to establish a relationship between calculated API values and instantaneous streamflow. The model was initially evaluated with data from five 'calibration' watersheds. Absolute errors in peak flow and storm runoff volume estimates, compared to observed values, for the calibration watersheds averaged 15 and 14%, respectively. Coefficients for the five calibration watersheds were also used to determine API coefficients for a sixth 'test' watershed. Absolute errors in peak flow and storm runoff volume estimates, compared to observed values, for the test watershed averaged 18 and 21%, respectively; average errors were -6 and -4%, respectively. The API model has minimal data requirements and appears to provide a relatively simple, objective method for simulating storm hydrographs from a wide variety of storm hyetographs. (Author's abstract)
W90-08221

TRACING RUNOFF SOURCES WITH DEUTERIUM AND OXYGEN-18 DURING SPRING MELT IN A HEADWATER CATCHMENT, SOUTHERN LAURENTIANS, QUEBEC.
Simon Fraser Univ., Burnaby (British Columbia). Dept. of Geography.
R. D. Moore.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 135-148, December 1989. 3 fig, 6 tab, 11 ref.

Descriptors: *Deuterium, *Headwaters, *Isotopic tracers, *Mountain watersheds, *Oxygen isotopes, *Quebec, *Snowmelt, *Storm runoff, *Tracers, Catchment areas, Diurnal variation, Hydrograph analysis, Runoff volume, Sampling, Seasonal variation, Sensitivity analysis, Streamflow, Uncertainty, Vadose zone.

Deuterium and oxygen-18 were used as passive tracers to separate streamflow into 'old' or 'pre-event' and 'new' or 'event' components during spring snowmelt in 1987 in a small catchment in the southern Laurentians of Quebec. The old water component of flow appeared to respond to the diurnal snowmelt cycle, accounting for up to 85% of the hydrograph rise from morning to late afternoon. Assumptions concerning constancy of new water concentrations and homogeneity of old water were not satisfied; however, sensitivity analyses indicated that it can be concluded that old water was a major component of streamflow. Mobilization of old vadose storage may have been an important process in runoff generation. Sampling variability of new water concentrations is documented, showing consequent uncertainty in separations. (Author's abstract)
W90-08222

INVESTIGATION OF TURBULENT FLOW OVER DUNES.
Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
C. Mendoza, and H. W. Shen.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 459-477, April 1990. 8 fig, 1 tab, 39 ref. NSF Grants ENG-7825054 and ECS 8515131.

Descriptors: *Alluvial channels, *Channel morphology, *Dunes, *Model studies, *Sediment transport, *Streambeds, *Turbulent flow, Finite difference methods, Flow resistance, Hydraulic engineering, Mathematical equations, Mathematical models, Open-channel flow, Shear stress.

Sand dunes occur frequently over alluvial stream beds and affect flow resistance and sediment transport. The turbulent-flow field above dunes is predicted with equations describing the transport of the kinetic energy of turbulence (k), its rate of dissipation (epsilon), and algebraic relations derived from a second-moment turbulence closure (Algebraic Stress Model). The resulting set of expressions jointly with the identified boundary conditions were solved with a computer code based on a finite-difference solution that uses the PISO algorithm to handle coupling between the continuity and momentum equations to obtain mean velocity and turbulent-stress profiles in the flow field, turbulent kinetic energy, and pressure and shear stress distributions over the dune surface. Estimates of flow resistance were obtained by integrating the pressure and shear stress distributions acting on the dune surface. Predictions compared well with detailed data of experiments on turbulent open-channel flow over dunes and with experimental data of total flow resistance. (Author's abstract)
W90-08251

LINEAR HYPERBOLIC MODEL FOR ALLUVIAL CHANNELS.
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-08252

PHYSICALLY BASED FLOOD FEATURES AND FREQUENCIES.
California Univ., Berkeley. Dept. of Civil Engineering.
H. W. Shen, G. J. Koch, and J. T. B. Obeysekera.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 494-514, April 1990. 7 fig, 4 tab, 34 ref, append. Army Grant DAAG29-83-K-0160.

Descriptors: *Flood forecasting, *Flood frequency, *Hydrograph analysis, *Rainfall-runoff relationships, *Runoff forecasting, Flood hydrographs, Flood peak, Hydrologic models, Kinematic wave theory, Model testing, Numerical models.

Hydrographs and flood-frequency distributions are often required for hydrologic and hydraulic analysis of small ungauged basins. Due to the lack of runoff data, a numerical model to relate rainfall with runoff cannot be used without appropriate calibration. Thus, it would be extremely useful to obtain critical elements of hydrograph and flood-peak distribution for small ungauged basins from rainfall and basin characteristics. Simple expressions were developed to express the time of concentration, time to peak, and peak flows as functions of basin and storm characteristics for small basins, based on results obtained from a specially derived kinematic wave rainfall-runoff model. Flood-peak distributions were derived based on the assumption that the arrival of storm events can be modeled by a Poisson process, and that the relationship (as derived from this study) expressing peak flow as a function of rainfall and basin characteristics is valid. The derived flood-frequency distributions were applied to several contrived basins with various storm and basin characteristics. For the small basins used in the study, the soil types and initial soil moisture exerted a strong influence on floods of a given frequency indicating that an accurate estimation of the soil properties is extremely important. (VerNooy-PTT)
W90-08253

LEAST-SQUARES PARAMETER ESTIMATION FOR MUSKINGUM FLOOD ROUTING.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
A. A. Aldama.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 580-586, April 1990. 1 fig, 3 ref.

Descriptors: *Estimating equations, *Flood forecasting, *Flood routing, *Hydraulic engineering, *Routing, Comparison studies, Flood peak, Least squares method, Mathematical analysis.

The importance of flood routing in rivers has been vastly recognized in hydraulic engineering practice. Field data scarcity often prevents the use of the Saint Venant equations to route floods in natural streams. As a consequence, approximate techniques such as the Muskingum method are employed. Three available least-squares parameter estimation techniques for Muskingum routing were compared. Explicit expressions for computing the routing parameters were obtained for Gill's and modified O'Donnell's techniques. A significant drawback of Heggen's methodology is that it requires the iterative solution of an algebraic equation that may lead to a root that does not necessarily represent the global minimum of the corresponding function. It was shown by numerical experiments that Gill's estimates of the storage parameter and the weighting factor are better suited for forecasting purposes than Heggen's and modified O'Donnell's. On the other hand, Gill's procedure appears to be most adequate for the prediction of a river reach response to inflow hydrographs different from the one used for calibration of the routing parameters. (VerNooy-PTT)
W90-08258

SKIMMING FLOW IN STEPPED SPILLWAYS.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-08259

APPRAISAL OF THE 'REGION OF INFLUENCE' APPROACH TO FLOOD FREQUENCY ANALYSIS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
D. H. Burn.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 2, p 149-165, April 1990. 5 fig, 5 tab, 9 ref.

Descriptors: *Data interpretation, *Flood frequency, *Regional floods, Data acquisition, Flow, Regionalization techniques.

Regional flood frequency analysis entails the pooling of data from sites within a defined region to enhance the estimation of at-site quantiles. Conventional regionalization techniques normally identify a fixed set of stations forming a contiguous region. An approach to regional flood frequency analysis that involves each site having a potentially different set of stations included for the at-site estimations of extremes was compared with a more traditional regionalization technique. The characteristics of the stations identified as being of relevance for the purposes of at-site estimation using the two approaches were contrasted and also the extreme flow values obtained were compared. The results indicated that the region of influence approach results in a group of stations with greater homogeneity than was the case for the regionalization technique and also leads to extreme flow estimates which are more accurate. (Author's abstract)
W90-08267

DERIVATION OF AN EXPLICIT EQUATION FOR INFILTRATION ON THE BASIS OF THE MEIN-LARSON MODEL.
Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft.
B. H. Schmid.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 2, p 197-208, April 1990. 4 fig, 2 tab, 7 ref.

Descriptors: *Infiltration rate, *Mathematical studies, *Overland flow, *Rainfall-runoff relationships, *Storm runoff, Mein-Larson model, Ponding, Runoff.

In the context of overland flow modeling, an explicit equation describing the process of infiltration is desirable, especially if aspects of kinematic shock routing are to be considered. Proceeding from the well-known infiltration model by Mein and Larson and several extensions, explicit equations for time-dependent infiltration rate and cumulative infiltration were proposed. Although the time-range of validity is limited due to the chosen mode of derivation, the formulae seem well suited for appli-

cation in the course of storm runoff modelling for small catchments. Major advantages of the proposed equations are the comparatively simple structure and a high degree of versatility, which explicitly accounts for a considerable number of effects. The parameters involved can be identified from measurements. Results are sufficiently accurate within a certain range of time after ponding, which can be estimated by means of a given rule of thumb. The equation proposed is particularly well suited for the computation of cumulative infiltration as required in the course of the integration of kinematic overland flow characteristics. (Miller-PTT)
W90-08270

RISK EQUIVALENT SEASONAL DISCHARGE PROGRAMS FOR MULTIDISCHARGER STREAMS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W90-08273

SIMPLE STOCHASTIC MODEL FOR ANNUAL FLOWS.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
A. G. Capodaglio, and U. Moisello.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 220-232, March/April 1990. 6 fig, 6 ref.

Descriptors: *Annual streamflow, *Hydrology, *Stochastic models, *Streamflow forecasting, Flow, Hursts phenomenon, Time series analysis.

Persistence is a phenomenon greatly influencing hydrologic time series. An explanation of its nature has been attempted in different ways, including transitory behavior or infinite memory of the process, and nonstationary process mean. An operational stochastic model for annual discharges was studied; its purpose was to reproduce the alternance of periods, sometimes called cycles, observed in hydrology. The model was almost immediately applicable, being defined by parameters that could be estimated easily through the analysis of the autocorrelation function of the observed data. The model was expressed in two forms that are valid for the cases of normal and lognormal distributions of the variables, respectively. The dependence of the parameters of the variables distribution on the operating parameters of the process was graphically represented by curves interpolated from a large number of sampling points. The performance of the model was also evaluated with respect to its behavior in accordance to Hurst's phenomenon, by verifying the values assumed by Hurst's coefficient during the simulations. (Author's abstract)
W90-08276

CALIBRATION OF SWMM RUNOFF QUALITY MODEL WITH EXPERT SYSTEM.
C. Baffaut, and J. W. Delleur.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 247-261, March/April 1990. 3 fig, 3 tab, 22 ref.

Descriptors: *Expert systems, *Model studies, *Storm runoff, *Urban hydrology, Calibrations, Pollution load.

EPA's storm water management model (SWMM) simulates urban runoff quantity and quality. An interactive program was developed by using expert system technology to automate the calibration of the water-quality parameters of the runoff block of SWMM. It acts as a front end in the estimation of the parameters and the buildup of the input files. Production rules are employed for the interpretation of the simulation results in order to suggest some useful adjustments of the significant parameters. The goal of the expert system is to obtain a set of parameters for which the predicted pollutant loads are close to the measured loads. The expert system has been tested on several watersheds, proving that it could perform the calibration but that a shortcoming exists in the model itself that

Field 2—WATER CYCLE

Group 2E—Streamflow and Runoff

cannot be alleviated through calibration. The Denver experiment showed that the same set of parameters is not valid for low-intensity and high-intensity events. (Author's abstract)
W90-08278

GEOMORPHOLOGIC RAINFALL-RUNOFF MODEL: INCORPORATING PHILIP'S INFILTRATION EXPRESSION.
Cairo Univ., Giza (Egypt). Dept. of Irrigation and Hydraulics.
For primary bibliographic entry see Field 2B.
W90-08279

AMUR BREAM, PARABRAMIS PEKINESIS, IN THE AMU DARYA LOWLAND WATER BODIES.
Karakalpakskii Kompleksnyi Nauchno-Issledova-telskii Inst., Nukus (USSR).
For primary bibliographic entry see Field 8I.
W90-08292

CHANGES IN BIOLOGICALLY CONTROLLED CARBON FLUXES IN A SMALL STREAM FOLLOWING CONTINUOUS SUPPLY OF EXCESS ORGANIC LOAD.
Universite de Savoie, Chambery (France). Lab. d'Ecologie.
For primary bibliographic entry see Field 5B.
W90-08307

DYNAMICS OF SESTON CONSTITUANTS IN THE ARIEGE AND GARONNE RIVERS (FRANCE).
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
E. Chauvet, and A. Fabre.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 183-190, March 15, 1990. 3 fig, 3 tab, 32 ref.

Descriptors: *Ariege River, *France, *Garonne River, *Seston, Algae, Algal growth, Organic carbon, Phosphorus, Pigments, Productivity, Seasonal variation, Suspended solids.

Water contents of suspended matter, algal pigments, particulate organic carbon and particulate phosphorus were measured in the rivers Garonne (2 sites) and Ariege (1 site) in France, throughout an annual cycle. The general trend of the parameters was similar at the three sites. Depending on the sites, the period of algal growth (chlorophyll a + phaeopigments > 25 microgm/L), lasted from two to six weeks in August-September. The algal peaks reached 50 to 90 microgm/L of total pigments. High contents of particulate organic carbon (>2 mg/L) occurred at the end of summer (coinciding with algal growth), and during the November and May floods. In summer 50-75% of the suspended matter was organic, in spring this was 10 times less. The high linear correlation between particulate organic carbon and pigment contents (r = 0.87; P = 0.0001) suggested an algal origin of at least part of the particulate carbon. Algal carbon was minor in the annual fluxes of particulate carbon (25 to 39% depending on the sites), but relatively high in comparison with other rivers. The mean particulate phosphorus content calculated over the year was 24 microgm/L; it varied from 15 microgm/L during the high water period to 28 microgm/L during the low water period. Likewise the percentage of particulate phosphorus in the suspended matter varied from 0.17 to 0.40. A negative linear correlation existed between particulate phosphorus content and specific discharge (r = -0.46; P = 0.0001). The very marked seasonal trend of the parameters and the interactions led to the differentiation of two modes of the rivers' functioning: a 'hydrologic' phase and a 'biological' phase. The hydrologic phase (high water) was dominated by the processes of erosion and transfer over the whole catchment area and the flood plain, while the biological phase was characterized by a high primary production in the river bed. (Author's abstract)
W90-08311

IDENTIFICATION OF RUNOFF-PRODUCTION MECHANISMS USING ENVIRONMENTAL ISOTOPES IN A TUSSOCK GRASSLAND CATCHMENT, EASTERN OTAGO, NEW ZEALAND.
James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Geography.
M. Bonnell, A. J. Pearce, and M. K. Stewart.
Hydrological Processes HYPRE3, Vol. 4, No. 1, p 15-34, January/March 1990. 7 fig, 4 tab, 33 ref.

Descriptors: *Environmental tracers, *Grasslands, *New Zealand, *Rainfall-runoff relationships, *Storm runoff, *Tracers, Flood hydrographs, Groundwater runoff, Hydrography, Isotopic tracers, Recession curve, Stream discharge, Surface runoff.

A previous hydrometric study of runoff production in tussock grassland drainage basins in Otago, New Zealand, revealed a marked change of slope in storm hydrograph recessions. An environmental isotope study was initiated to investigate the runoff mechanisms operating and to test specific hypotheses to explain this break in the hydrograph recession. The results indicated that for quickflow volumes in excess of 10 mm, the first part of the storm hydrograph can be attributed to two separate sources, namely, 'old' water from a shallow, unconfined groundwater reservoir and 'new' water from saturation overland flow. Substantial surface storage in the wetlands has to be exceeded before rain becomes a significant part of stream discharge. For quickflow volumes less than 10 mm, only 'old' water from groundwater contributes to the first part of the hydrograph recession. This means that only the largest 7 percent of storms (in terms of quickflow volume) generate quickflow containing significant amounts of 'new' water. The second part of the recession of the storm hydrograph consists of 'old' water derived from a remarkably well-mixed shallow unconfined groundwater body. (Author's abstract)
W90-08325

CHARACTERISTICS OF SUSPENDED SEDIMENT IN THE UPPER RHONE RIVER, SWITZERLAND, INCLUDING THE PARTICULATE FORMS OF PHOSPHORUS.
Geneva Univ. (Switzerland). Inst. F.-A. Forel.
For primary bibliographic entry see Field 5B.
W90-08330

DESIGN OF HYDRAULIC JUMP CHAMBERS.
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W90-08353

SUBMARINE SEDIMENTATION ON A DEVELOPING HOLOCENE FAN DELTA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Atlantic Geoscience Centre.
For primary bibliographic entry see Field 2J.
W90-08380

MASS TRANSFER MECHANISM IN A POROUS RIVERBED.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
H. Nagaoka, and S. Ohgaki.
Water Research WATRAG, Vol. 24, No. 4, p 417-425, April 1990. 14 fig, 1 tab, 7 ref.

Descriptors: *Biofilms, *Eddy diffusion, *Fate of pollutants, *Mass transport, *Porous riverbeds, *River beds, *Self-purification, *Wastewater treatment, Analytical methods, Diffusion coefficient, Hydrodynamics, Model studies, Turbulent flow.

Self-purification in rivers and streams is carried out mostly by attached microorganisms in riverbeds and streambeds. Porous riverbeds are thought to be superior to flat riverbeds in the potential for self-purification or for open-channel advanced wastewater treatment. Turbulence, which is produced at the surface of a porous bed, is thought to enhance the activity of riverbed biofilms. A study was conducted to examine the hydrodynamic characteristics in and over the porous bed. The mass

transfer mechanism was investigated in two experimental open channels which have porous beds composed of 1.09 and 4.08 cm diameter ceramic balls, respectively. Vertical diffusion coefficients in the porous beds were determined by analyzing the diffusional pattern of tracer (NaCl) from the overlying water into the deeper region of the porous bed. Velocity profiles both over and under the water-bed interface and turbulence at the interface was measured. The diffusion coefficients in the porous beds were expressed by the product of velocity component and mixing length along every depth of the porous bed. Near the interface, the diffusion coefficient was expressed by the product of the turbulent intensity and the void scale of the porous layer. In the deeper region of the porous bed, the diffusion coefficient was expressed by the product of the time-averaged velocity and the void scale. (Chonka-PTT)
W90-08382

MEASUREMENT OF ELECTRON TRANSPORT SYSTEM ACTIVITY IN RIVER BIOFILMS.
University Coll. of North Wales, Bangor. School of Biological Sciences.
For primary bibliographic entry see Field 7B.
W90-08385

DISTRIBUTION OF FINGERLING BROOK TROUT, SALVELINUS FONTINALIS (MITCHILL), IN DISSOLVED OXYGEN CONCENTRATION GRADIENTS.
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 2H.
W90-08463

MOVEMENTS OF CHANNEL AND FLATLAND CATFISH BETWEEN THE MISSOURI RIVER AND A TRIBUTARY, PERCHE CREEK.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
For primary bibliographic entry see Field 4C.
W90-08467

HYDROLOGY.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 2A.
W90-08533

ENGINEERING MEASURES: WATER HARVESTING.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 3F.
W90-08539

FLOOD HYDROLOGY.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
E. L. White.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 127-143, 7 fig, 1 tab, 35 ref.

Descriptors: *Caves, *Flood flow, *Groundwater movement, *Karst hydrology, *Kentucky, *Mammoth Cave, *Surface-groundwater relations, Flood hydrographs, Floods, Green River, Infiltration, Karst.

Many cave conduits, which are below the base level and subject to solution, are within the Flint-Mammoth Cave system, Kentucky. Above the base level of both surface and groundwater systems is a floodwater zone. The floodwater zone is defined as the elevation between low stage of the regional water table and the highest flood level per year. The role of the seasonal rise and fall of base level allows the cave passages to drain, breakdown to fall, and sediment to be transported (both erosion and deposition). The passages subject to flooding are still enlarging with the rise and fall of base level. Flood flow is strongly influenced by the presence of conduit-type underground drainage systems. Watersheds underlain by carbonate rocks are among the most peculiar. Rainfall that infil-

trates into the absorbing soils is temporarily stored at the corroded bedrock surface called the subcutaneous zone. Because the open-conduit system has a storage potential for a higher proportion of the precipitation from a storm, initial flood pulses from sinking streams and sinkhole internal runoff are absorbed into the conduit system, thereby reducing the total volume of flow at any position of the surface stream (flood damping). The flood damping is proportional to the extent of karstic development of the drainage basin. It is reflected in the flood hydrograph, which tends to have a lower peak value and a somewhat more drawn out recession limb than hydrographs for an equivalent drainage basin without the karstic component. The capture of the internal runoff from an extreme value flood via sinkhole input into the subsurface drainage has another effect. The groundwater trough along the conduit system fills rapidly when subjected to high intensity precipitation. If the rapidly rising water table reaches the surface, the drain channels of sinkholes can reverse their flow, filling the closed depressions and transforming them into small lakes. The Green River flows in a narrow valley through much of its route through the central Kentucky karst. Because the Green River flows in a narrow valley, floods are accompanied by large rises in river stage with accompanying flooding of many cave passages that lie within the flood range. Low-gradient trunk passages are arrayed in tiers from below pool stage at 125 m to 250 m elevation with major levels separated by only 20 m. Because of the low gradients, flooding extends a considerable distance back into the aquifer. (See also W90-08542) (Lantz-PTT)
W90-08547

SPECIAL FLOOD HAZARD EVALUATION REPORT: DONNER CREEK, CITY OF NORTH TONAWANDA, NIAGARA COUNTY, NEW YORK.
Army Engineer District, Buffalo, NY.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A203-673. Price codes: A03 in paper copy, A01 in microfiche.
October 1988. 18p, 1 fig, 2 tab, 3 plates, 3 ref.

Descriptors: *Culverts, *Donner Creek, *Flood control, *Flood hazard, *Flood plain management, *Hazard assessment, *Hydraulic structures, *New York, Flood channels, Flood protection, Flood routing, Regulations.

This report documents the results of an investigation to determine the potential flood situation along Donner Creek (also known as Black Creek). The study reach extends along Donner Creek from immediately upstream of the Central Railroad tracks, upstream to the corporate limit, a distance of about 4,700 feet. The primary cause of flooding along Donner Creek is the undersized culverts at River Road, Warner Avenue, and Witmer Road, which cause water to back up during a rainfall event. To date, flooding has been limited to street and yard flooding; however, water infiltrates the sanitary sewers through man-hole covers and causes sewer back-up and basement flooding. Both structural and nonstructural alternatives are available to alleviate or lessen the flood threat. Nonstructural alternatives include implementing flood plain regulations that would limit or prohibit future growth in the flood plain. Thus, flood damages would not increase. Structural solutions can also be implemented to alleviate or lessen flood threat. The culverts under River Road, Warner Avenue, and Witmer Road can be enlarged to adequately pass the flood flow. However, due to the suspected presence of toxic material in the ground, it may not be possible to replace the River Road culvert. In that case, either a pumping system or an extension to the City storm sewer system would have to be installed in the vicinity of Donner Pond. If this was not done, the increased flow from the upper portion of the watershed due to replacing the two upstream culverts would significantly increase flooding in the Donner Pond area. The pumping system would consist of a pump at Donner Pond and either a temporary discharge pipe installed across River Road during each flood event or a permanent discharge pipe installed inside the existing culvert. The storm sewer extension would run from Donner Pond northwesterly along the city

owned railroad right-of-way and would discharge into the City's proposed northwest storm sewer system. (Lantz-PTT)
W90-08559

ANNUAL RAINWATER POTENTIAL AND ITS VARIABILITY IN DROUGHT YEARS OVER ETHIOPIA.
National Meteorological Services Agency, Addis Ababa (Ethiopia).
For primary bibliographic entry see Field 2B.
W90-08581

INFLUENCE OF GLACIERISATION ON THE RESPONSE OF RUNOFF FROM ALPINE BASINS TO CLIMATE VARIABILITY.
Victoria Univ. of Manchester (England). Alpine Glacier Project.
For primary bibliographic entry see Field 2C.
W90-08589

CLIMATE VARIATION AND ICE CONDITIONS IN THE RIVER TORNEALVEN.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
For primary bibliographic entry see Field 2C.
W90-08592

ESTIMATING THE IMPACTS OF CLIMATIC CHANGE ON RIVER FLOWS: SOME EXAMPLES FROM BRITAIN.
Institute of Hydrology, Wallingford (England).
N. Arnell, and N. Reynard.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 426-436, 2 fig, 2 tab, 10 ref.

Descriptors: *Climatic changes, *Climatology, *England, *Global warming, *River flow, Model studies, Precipitation, Regression analysis, Resources management, Seasonal variation.

Future climatic changes may have a very significant effect on water resource availability, and the results from studies of possible impacts will facilitate efficient resource management. The sensitivities of average annual runoff in Britain to changes in annual precipitation and evaporation have been examined using a regional relationship, and it has been shown that changes in runoff are much more sensitive to changes in precipitation. The greatest sensitivity is found in the drier southeast. A simple regression model was used to generate time series of monthly flows under current and perturbed climates at several sites in Britain. Flow seasonality was shown to increase in a warmer, wetter world, and flows in groundwater catchments may be sustained during drier summers by greater winter and spring rainfall totals. (See also W90-08565) (Author's abstract)
W90-08597

LONG-TERM TRENDS IN RIVER FLOW IN FINLAND.
National Board of Waters, Helsinki (Finland).
Water Research Inst.
V. Hyvarinen, and R. Leppajarvi.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 450-461, 7 fig, 1 tab, 4 ref.

Descriptors: *Climatic changes, *Finland, *Global warming, *River flow, *Streamflow data, Greenhouse effect, Lake level, Precipitation, Runoff, Seasonal variation.

A selection of long-term Finnish discharge observation series has been analyzed. The time series studied were: (1) mean annual discharge in the Vuoksi at Imatra; (2) ten year means of annual precipitation and runoff for three large river basins; (3) mean annual discharges, spring and autumn high flows, and winter and summer low flows for 13 basins; and (4) winter discharges, monthly means of December and March for a selection of basins. Annual discharges have gener-

ally increased slightly in most of Finland and especially in the 1980's, but it is too early to decide if this is due to climatic change or to climatic fluctuations. Winter discharges have increased by as much as 20 per cent in some Finnish lakes during the 20th century. This trend is in line with results of climate models, which suggest that both precipitation and temperature are increasing as a result of atmospheric greenhouse effect, especially at northern latitudes in winter. (See also W90-08565) (Author's abstract)
W90-08599

2F. Groundwater

GROUNDWATER MONITORING: GUIDELINES AND METHODOLOGY FOR DEVELOPING AND IMPLEMENTING A GROUNDWATER QUALITY MONITORING PROGRAM.
Kaman Tempo, Santa Barbara, CA.
For primary bibliographic entry see Field 5A.
W90-07514

LAKE SACAJAWEA RESTORATION PROJECT, CITY OF LONGVIEW, WASHINGTON.
Gibbs and Olson, Inc., Longview, WA.
For primary bibliographic entry see Field 5G.
W90-07516

WELL INSTALLATION AND GROUNDWATER SAMPLING PLAN FOR 1100 AREA ENVIRONMENTAL MONITORING WELLS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 7A.
W90-07552

HANDBOOK OF GROUNDWATER PROTECTION.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 5G.
W90-07561

CONICAL KARST: ITS ORIGIN FROM THE EXAMPLE OF THE SOUTH CHINA KARST (LE KARST CONIQUE: SA GENESE A PARTIR DE L'EXEMPLE DU KARST DU SUD DE LA CHINE).
Centre National de la Recherche Scientifique, Moulis (France). Lab. Souterrain.
A. Mangin, and M. Bakalowicz.
Comptes Rendus de l'Academie des Sciences (Serie 2) CRASEV, Vol. 310, No. 3, p 301-307, February 1, 1990. 1 fig, 17 ref. English summary.

Descriptors: *China, *Geohydrology, *Geologic erosion, *Geologic history, *Geomorphology, *Karst, *Karst hydrology, Carbonates, Erosion rates, Model studies.

New observations on the karst of South China, based on a global hydrogeological approach, show that present orogenic conditions give a much better understanding of their development than the climatic conditions usually set forth. The formation of conical karst may be described by the following sequence: During the initial phase, most of the carbonate dissolution occurs near the surface, in the epikarstic zone. This phenomenon is due to rapid infiltration which alone is responsible for deep dissolution and the creation of underground drainage. On the one hand, when the hydraulic gradient is high and carbonate deposits are appreciable, the potential of karstification is sufficient for the rapid development of an underground karst drainage. On the other hand, if the hydraulic gradient remains weak a surface run-off drainage slowly develops. Because of the permanent uplift, the basin level slowly subsides. Regional potential karstification then remains weak and erosion occurs mostly at the surface. Nevertheless, locally, at the catchment area boundaries or near the meanders, the potential may be considerable; in such circumstances underground karst drainages are developed. On the regional scale, this permanent uplift is very conducive to active surface erosion which is subject to fluvial drainage. In the final analysis, in

classical karst, an underground flow pattern develops and is responsible for most of the landscape formation. In conical karst, even if the epikarstic zone promotes carbonate dissolution, it is the flows, mostly surface ones, which are responsible for landscape evolution. (Chonka-PTT)
W90-07567

ON-LINE PRECONCENTRATION OF SILVER ON ACTIVATED ALUMINA AND DETERMINATION ON BOREHOLE WATER BY FLOW INJECTION ATOMIC ABSORPTION SPECTROPHOTOMETRY.
For primary bibliographic entry see Field 7B.
W90-07568

MODELING MANAGEMENT PRACTICE EFFECTS ON PESTICIDE MOVEMENT TO GROUND WATER.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-07602

ASSESSMENT OF PESTICIDES IN UPSTATE NEW YORK GROUND WATER: RESULTS OF A 1985-1987 SAMPLING SURVEY.
New York State Water Resources Research Inst., Ithaca.
For primary bibliographic entry see Field 5B.
W90-07603

NATIONAL EVALUATION OF THE LEACHING POTENTIAL OF ALDICARB. PART 2. AN EVALUATION OF GROUND WATER MONITORING DATA.
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5B.
W90-07604

ACCOUNTING FOR TEMPORAL VARIATIONS IN LARGE-SCALE RETROSPECTIVE STUDIES OF AGRICULTURAL CHEMICALS IN GROUND WATER.
Research Triangle Inst., Research Triangle Park, NC. Hydrogeology Dept.
For primary bibliographic entry see Field 7A.
W90-07605

GROUND WATER MONITORING STUDY FOR PESTICIDES AND NITRATES ASSOCIATED WITH GOLF COURSES ON CAPE COD.
Biospherics, Inc., Beltsville, MD.
For primary bibliographic entry see Field 5B.
W90-07607

MONTE CARLO ANALYSIS AND BAYESIAN DECISION THEORY FOR ASSESSING THE EFFECTS OF WASTE SITES ON GROUNDWATER, II: APPLICATIONS.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
M. A. Medina, J. B. Butcher, and C. M. Marin.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 1, p 15-31, December 1989. 4 fig, 3 tab, 14 ref. Water Resources Research Institute of the University of North Carolina and the Division of Environmental Management, Department of Natural Resources and Community Development (State of North Carolina) Grant No. 87-17-70058.

Descriptors: *Bayesian decision theory, *Groundwater pollution, *Hazardous waste disposal, *Model studies, *Monte Carlo method, *Risk assessment, *Waste disposal, *Water pollution effects, Computer programs, Landfills, North Carolina, Path of pollutants.

Sequential Bayesian risk methodology is utilized for the assessment of the effects of waste sites on groundwater. Specific details of the Monte Carlo implementation depend on the contaminant transport model employed. The Method of Characteristics (MOC) model of Konikow and Bredehoeft is one of several numerical and analytical models that can support the sequential risk methodology. Development of the Monte Carlo analysis with the MOC first requires a choice of the sources of uncertainty that are to be considered in the model input. In a rigorous application of the Monte Carlo method all of the input parameters should be described by probability distributions, although that approach is generally impractical. Normally a limit is placed upon the number of sources of uncertainty, and a sensitivity analysis is performed to develop information about the importance of the various sources of uncertainty. The sensitivity analysis assesses the impacts of the various sources of uncertainty incorporated, and emphasizes the need to explicitly consider such uncertainty in the process of risk assessment for regulatory decision. An example of a lined hazardous waste landfill is used for the sensitivity analysis. Three general categories of uncertainty were considered: uncertainty in the time of failure of the landfill containment system, uncertainty in the release concentration given occurrence of failure, and uncertainty in the specification of the spatially covarying hydraulic conductivity field. Similar modifications to a wide range of contaminant transport models have been incorporated into an advisory computer system for groundwater quality modeling and management. (See also W90-07614) (Tappert-PTT)
W90-07615

ASSESSMENT OF GROUNDWATER CONTAMINATION RESULTING FROM A MAJOR ACCIDENT IN LAND NUCLEAR POWER PLANTS (LNPP), I: CONCEPTS AND METHODOLOGY.
TAHAL-Water Planning for Israel Ltd., Tel-Aviv.
For primary bibliographic entry see Field 5B.
W90-07616

ASSESSMENT OF GROUNDWATER CONTAMINATION RESULTING FROM A MAJOR ACCIDENT IN LAND NUCLEAR POWER PLANTS (LNPP), II: EVALUATION OF A MELT-THROUGH EVENT.
TAHAL-Water Planning for Israel Ltd., Tel-Aviv.
For primary bibliographic entry see Field 5B.
W90-07617

COMPARISON OF OXIDATION-REDUCTION POTENTIALS CALCULATED FROM THE AS(V)/AS(III) AND FE(III)/FE(II) COUPLES WITH MEASURED PLATINUM-ELECTRODE POTENTIALS IN GROUNDWATER.
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
For primary bibliographic entry see Field 2K.
W90-07618

EXPERIMENTAL OBSERVATIONS OF MULTIPHASE FLOW IN HETEROGENEOUS POROUS MEDIA.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5B.
W90-07619

KINETICALLY INFLUENCED TERMS FOR SOLUTE TRANSPORT AFFECTED BY HETEROGENEOUS AND HOMOGENEOUS CLASSICAL REACTIONS.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W90-07636

STOCHASTIC MODELING OF MACRODISPERSION IN HETEROGENEOUS POROUS MEDIA.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-07645

MACRODISPERSION IN SAND-SHALE SEQUENCES.
Geological Survey of Canada, Ottawa (Ontario).
For primary bibliographic entry see Field 5B.
W90-07647

DETERMINATION OF FRACTURE INFLOW PARAMETERS WITH A BOREHOLE FLUID CONDUCTIVITY LOGGING METHOD.
California Univ., Berkeley. Lawrence Berkeley Lab.
C. F. Tsang, P. Hufschmied, and F. V. Hale.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 561-578, April 1990. 25 fig, 9 tab, 21 ref. DOE Contract DE-AC03-76SF00098.

Descriptors: *Borehole geophysics, *Groundwater movement, *Hydrogeology, *Rock properties, Borehole fluid conductivity logging, Fractured rocks, Inflow rates.

There is much current interest in determining the flow characteristics of fractures intersecting a well bore in order to provide data for use in estimating the hydrologic behavior of fractured rocks. Inflow rates from these fractures into the well bore are usually very low. Moreover, in most cases only a few percent of the fractures identified by core inspection and geophysical logging actually conduct water, the rest being closed, clogged, or isolated from the water flow system. A new procedure is proposed and a corresponding method of analysis developed to locate water-conducting fractures and obtain fracture inflow rates by means of a time sequence of electric conductivity logs of the borehole fluid. The physical basis of the analysis method is discussed, and the procedure is applied to an existing set of data, which shows initiation and growth of nine conductivity peaks in a 900-m section of a 1690-m borehole, corresponding to nine water-conducting fractures intersecting the borehole. By applying the analysis to these nine peaks, the flow rates and the salinity of the water from these fractures are determined. These results are used with other information to obtain transmissivities of the nine fractures, which are validated against independent hydraulic measurements by packer tests. The salinities measured in fluids from the fractures are also validated against salinity values obtained by chemical sampling of fluids from different depths of the borehole. Fluid logging techniques have several advantages and may play a significant part in a well-planned testing program by: (1) allowing an identification of the locations of water-conducting fractures or groups of fractures in a borehole; and (2) aiding in the derivation of the hydraulic or flow properties, like transmissivity, of these identified water-conducting features. (Author's abstract)
W90-07667

SENSITIVITY ANALYSIS OF FLOW IN UNSATURATED HETEROGENEOUS POROUS MEDIA: THEORY, NUMERICAL MODEL, AND ITS VERIFICATION.
Princeton Univ., NJ.
For primary bibliographic entry see Field 2G.
W90-07670

COMPARISON OF BIODEGRADATION KINETICS WITH AN INSTANTANEOUS REACTION MODEL FOR GROUNDWATER.
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W90-07673

STOCHASTIC APPROACH TO THE PROBLEM OF UPSCALING OF CONDUCTIVITY IN DISORDERED MEDIA: THEORY AND UNCONDITIONAL NUMERICAL SIMULATIONS.
Stanford Univ., CA. Dept. of Applied Earth Sciences.
Y. Rubin, and J. J. Gomez-Hernandez.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 691-701, April 1990. 11 fig, 31 ref, 2 append.

Descriptors: *Conductivity, *Geohydrology, *Groundwater movement, *Mathematical models, *Model studies, *Solute transport, *Water chemistry, Flow simulation, Monte Carlo method, Path of pollutants.

A general problem in groundwater modeling is how to assign conductivity values to blocks of a numerical model. A method is proposed to upscale the conductivity measurements observed at a given scale to block conductivity values for arbitrary block size. Assuming a multilognormal distribution for the point conductivities, the block conductivity appears as a random function whose distribution, conditional to point measurements, can be derived. This conditional distribution allows filling the flow simulator blocks with equiprobable realizations of block conductivities locally conditioned to actual data. These realizations could also be conditioned to conductivity values measured at any scale if the size of the measurement support is known. The analytical results were compared to results obtained through a Monte Carlo analysis, and a good agreement was found. (Author's abstract)
W90-07677

REDUCTIONIST PHYSICAL APPROACH TO UNSATURATED AQUIFER RECHARGE FROM A CIRCULAR SPREADING BASIN.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
H. J. Morel-Seytoux, C. Miracapillo, and M. J. Abdulrazzak.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 771-777, April 1990. 11 fig, 17 ref.

Descriptors: *Aquifers, *Artificial recharge, *Groundwater recharge, *Infiltration, *Mathematical studies, *Recharge, Horizontal flow, Integro-differential equations, Spreading basins, Unsaturated zone, Vertical velocity.

The process of aquifer recharge from a circular area through the unsaturated zone was investigated. The same basic methodology described previously by the authors for the case of a long strip recharging area was applied. An approximate solution to the three-dimensional problem was obtained by matching two unidimensional flows, a vertical and a radial one. The mathematical formulation was obtained first for the case of a constant infiltration rate and then for a time-dependent rate through the unsaturated zone. The formulation leads to an integrodifferential equation whose solution is obtained numerically using the 'discrete kernel' approach. The procedure has the advantage of accounting for the change of specific yield in the aquifer below the infiltration basin and away from it. It also accounts for anisotropy and for the sharp curvature of the flow as the vertical recharge flux turns into horizontal flow. For a recharge problem these velocities are of the same order of magnitude and one cannot assume that the vertical velocity is negligible in comparison to the horizontal one everywhere in the flow domain. Also, a criterion to evaluate the efficiency of the recharge is provided for practical purposes. This criterion allows comparison between different recharge designs. (Author's abstract)
W90-07684

OPTIMAL PUMPING TEST DESIGN FOR PARAMETER ESTIMATION AND PREDICTION IN GROUNDWATER HYDROLOGY.
California Univ., Los Angeles. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W90-07685

SELENIUM IN THE SOUTHERN COAST RANGE OF CALIFORNIA: WELL WATERS, MAPPED GEOLOGICAL UNITS, AND RELATED ELEMENTS.
San Bernardino County Dept. of Environmental Health Services, CA.
For primary bibliographic entry see Field 5B.
W90-07697

GROUNDWATER CONTROL OF CLOSED-BASIN LAKE LEVELS UNDER STEADY-STATE CONDITIONS.
Minnesota Univ., Minneapolis. Limnological Research Center.
J. E. Almendinger.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/

4, p 293-318, January 1990. 12 fig, 1 tab, 23 ref, append. USGS grant 14-08-0001-G1233, and NSF grant NSF/EAR-8414060.

Descriptors: *Geohydrology, *Groundwater level, *Hydrologic models, *Model studies, *Surface-groundwater relations, *Water level, Groundwater recharge, Lake pumping, Lake size, Pumping rate, Runoff.

Groundwater exerts both local and regional controls on closed-basin lake-level changes. Locally, the aquifer surrounding a lake can modify how lake-level changes result from a shift in surficial water balance. 'Lake pumping' is defined as the net steady-state removal of lake water via surficial processes, namely evaporation minus direct precipitation and minus any input from overland runoff that reaches the lake. A simple analytic groundwater model of a circular lake next to an infinitely long river shows that the sensitivity of the lake level to a change in lake pumping is proportional to the distance from the lake to the river. Lakes with large surface areas are more sensitive than small lakes to a shift in lake pumping. A review of a simple analytic groundwater model of a water table between two infinitely long canals demonstrates that a shift in groundwater recharge changes the water-table elevation most near the middle of the interfluve. Three types of lake-level sensitivities are defined as the partial derivative of lake level with respect to: (1) lake size (radius); (2)lake pumping rate; and (3)regional groundwater recharge. All three sensitivities may be further categorized as 'positional sensitivities' because their values are a function of the lake's position in the watershed. Specifically, lakes far from rivers are more susceptible to lake-level change than are lakes close to rivers. Both simple models further demonstrate that lake sensitivity to the above factors is inversely proportional to the permeability of the surficial aquifer. When compared to a system of a more realistic geometric arrangement of lakes and rivers, the simple models underestimate lake-level change in response to both local and regional factors. (Author's abstract)
W90-07727

DOLOMITE DISSOLUTION RATES AND POSSIBLE HOLOCENE DEDOLOMITIZATION OF WATER-BEARING UNITS IN THE EDWARDS AQUIFER, SOUTH-CENTRAL TEXAS.
Geological Survey, Reston, VA.
R. G. Deike.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/ 4, p 335-373, January 1990. 2 fig, 7 tab, 41 ref, append.

Descriptors: *Aquifers, *Dolomite, *Edwards Aquifer, *Geomorphology, *Karst, *Texas, *Weathering, Chemical mass balance, Groundwater chemistry, Mineral mass balance, Permeability, Wastewater disposal.

Geomorphologic evidence suggesting 100,000 years for permeability enhancement in the Edwards aquifer is supported by dolomite dissolution rates from both the Edwards and other aquifers. Hypothetical rates from the Edwards based on a 100,000-yr reaction time are consistent with more accurate rates from other carbonate aquifers. This is true of separately derived hypothetical rates from the Edwards based on mineral as well as chemical mass balances. Further support of a 100,000-yr time span is obtained from dolomite surface-area reaction rates. When the mass loss of dolomite is expressed as a function of surface area, the results are consistent with both laboratory and field measurements. Results suggest that the mixing of two groundwaters of different composition can, in a carbonate aquifer system, quickly develop cavernous, or conduit, permeability. This situation can occur anthropogenically--for example, during the disposal of waste water of a different composition than resident water in a carbonate rock body. The factors that affect the reaction time are the mineralogy and permeability of the carbonate rocks, the degree of undersaturation created by the mixture of solutions, and the establishment of discharge points that allow the system to remove the products of dissolution and maintain hydrologic and geochemical conditions for continuing mass transfer. (Author's abstract)

W90-07730

USE OF STABLE ISOTOPE TRACERS FOR THE ESTIMATION OF THE DIRECTION OF GROUNDWATER FLOW.
B. R. Payne.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/ 4, p 395-401, January 1990. 7 fig, 1 ref.

Descriptors: *Ecuador, *Groundwater movement, *Isotopic tracers, *Korea, *Surface-groundwater relations, *Tracers, Groundwater recharge, Infiltration, Regression analysis, Spatial variation.

Spatial variation in the stable isotopic composition of groundwater is indicative of mixing of waters of different stable isotopic content. Infiltration losses from a river or lake are examples which result in a positive correlation with distance from the source of infiltration to the groundwater. A method for determining the direction of groundwater flow involves determining the regression of either $O18$ or deuterium against distance along the X-coordinate of each sampling location. This computation is made for given intervals, for example 5 degrees, of rotation of the axes through 180 degrees. The angle of rotation which results in the maximum value of the correlation coefficient determines the direction of groundwater flow. This approach was applied to field studies in Ecuador and the Republic of Korea. In the Korean case the estimated direction of flow agreed with the resultant of the two flow vectors obtained from water level contours. The results of the study of the Chimbo River in Ecuador indicate that, in the case of infiltration from a surface water body versus infiltration of local precipitation as a source of groundwater recharge, the variation of staple isotopic composition is not a linear function of distance. (White-Reimer-PTT)
W90-07732

NITRATE POLLUTION OF MITIDJA GROUNDWATERS (ALGIERS, ALGERIA).
Universite des Sciences et de la Technologie Houari Boumediene, Algiers (Algeria).
For primary bibliographic entry see Field 5B.
W90-07740

STUDY OF THE METAL CONTENT IIN THE WATERS OF THE PROTECTED REGION OF THE JUZERA MOUNTAINS.
Ceske Vysoke Uceni Technicke v Praze. Faculty of Civil Engineering.
For primary bibliographic entry see Field 5C.
W90-07741

RECOVERY OF HEPATITIS A VIRUS FROM A WATER SUPPLY RESPONSIBLE FOR A COMMON SOURCE OUTBREAK OF HEPATITIS A.
Georgia Dept. of Human Resources, Atlanta. Office of Epidemiology.
For primary bibliographic entry see Field 5B.
W90-07817

HYDRODYNAMIC CONDITIONS OF UNDERGROUND WATER FORMATION IN THE NAKHICHEVAN ASSR (IN RUSSIAN).
M. M. Mamedyarov.
Izvestiia Akademii Nauk Azerbaidzhanskoi SSR. Seria Nauk o Zemle Geologiia, No. 1, p 127-131, 1989. 3 ref. English summary.

Descriptors: *Geohydrology, *Nakhichevan ASSR, *Water circulation, *Water exchange, Drainage patterns, Geology, Mountains, Topography.

The Nakhichevan ASSR can be subdivided into two geohydrological subregions according to underground water formation conditions: mountain structures and lowland. Two hydrodynamic areas are singled out within each subregion: active water exchange areas, and deep circulation areas. The active water exchange area in the mountain structure includes a rock series above the local base

Group 2F—Groundwater

level drainage, while in the lowland, the rock series is below the local base level drainage. Both structures have a descending type of underground water circulation. Deep circulation areas in the mountain structure are characterized by continuous migration of groundwaters, which are enriched by a number of chemical compounds and carbon dioxide. The lowlands contain two water-bearing horizons, the Quaternary and the Sarmat deposits, in a deep area of active water exchange. (Author's abstract)
W90-07821

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MONTANA, OCTOBER 1987 THROUGH SEPTEMBER 1989.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-07838

STATISTICAL AND SIMULATION ANALYSIS OF HYDRAULIC-CONDUCTIVITY DATA FOR BEAR CREEK AND MELTON VALLEYS, OAK RIDGE RESERVATION, TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
J. F. Connell, and Z. C. Bailey.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4062, February 1990. 49p, 11 fig, 12 tab, 25 ref.

Descriptors: *Geohydrology, *Hydraulic conductivity, *Model studies, *Oak Ridge, *Simulation analysis, *Tennessee, Bear Creek Valley, Groundwater, Log-Pearson Type III distribution, Melton Valley, Regression analysis, Sensitivity analysis, Statistical analysis, Statistical grouping.

A total of 338 single-well aquifer tests from Bear Creek and Melton Valley, Tennessee were statistically grouped to estimate hydraulic conductivities for the geologic formations in the valleys. A cross-sectional simulation model linked to a regression model was used to further refine the statistical estimates for each of the formations and to improve understanding of ground-water flow in Bear Creek Valley. Median hydraulic-conductivity values were used as initial values in the model. Model-calculated estimates of hydraulic conductivity were generally lower than the statistical estimates. Simulations indicate that (1) the Pumpkin Valley Shale controls groundwater flow between Pine Ridge and Bear Creek; (2) all the recharge on Chestnut Ridge discharges to the Maynardville Limestone; (3) the formations having smaller hydraulic gradients may have a greater tendency for flow along strike; (4) local hydraulic conditions in the Maynardville Limestone cause inaccurate model-calculated estimates of hydraulic conductivity; and (5) the conductivity of deep bedrock neither affects the results of the model nor does it add information on the flow system. Improved model performance would require: (1) more water level data for the Copper Ridge Dolomite; (2) improved estimates of hydraulic conductivity in the Copper Ridge Dolomite and Maynardville Limestone; and (3) more water level data and aquifer tests in deep bedrock. (USGS)
W90-07839

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1987. VOLUME 1, GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-07844

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1987. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-07845

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988. VOLUME 1. EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-07846

GROUND-WATER SOURCES AND 1985 WITHDRAWALS IN FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-07851

FLOW PATTERN IN REGIONAL AQUIFERS AND FLOW RELATIONS BETWEEN THE LOWER COLORADO RIVER VALLEY AND REGIONAL AQUIFERS IN SIX COUNTIES OF SOUTHEASTERN TEXAS.
Geological Survey, Austin, TX. Water Resources Div.
D. G. Woodward.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4154, 1989. 24p, 13 fig, 17 ref.

Descriptors: *Flow pattern, *Groundwater movement, *Recharge, *Texas, Bastrop County, Colorado County, Discharge, Fayette County, Matagorda County, Potentiometric surface, Regional aquifers, Travis County, Wharton County.

The 318-river-mile reach of the Lower Colorado River from Mansfield Dam near Austin, Texas, to the Gulf of Mexico is underlain directly or indirectly by six regional aquifers—the Trinity, Edwards, Carrizo-Wilcox, Queen City, Sparta, and Gulf Coast. The Trinity aquifer is further subdivided into the lower Trinity, middle Trinity, and upper Trinity aquifers. Generalized potentiometric-surface maps of each regional aquifer show the groundwater flow pattern near the river valley. Each regional aquifer discharges water to the lower Colorado River valley, particularly in the outcrop area of each aquifer. Only the Gulf Coast aquifer in central Wharton County appears to be recharged by water in the river valley. A summary map shows those subreaches of the lower Colorado River that gain water from the aquifers and the subreaches that lose water to the aquifers. (USGS)
W90-07852

UNDERGROUND COAL MINES AS SOURCES OF WATER FOR PUBLIC SUPPLY IN NORTHERN UPSHUR COUNTY, WEST VIRGINIA.
Geological Survey, Charleston, WV. Water Resources Div.
W. A. Hobba.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 84-4115, 1987. 38p, 10 fig, 8 tab, 12 ref.

Descriptors: *Coal mines, *Mine drainage, *Storage capacity, *Underground storage, *Water quality, *Water resources development, *West Virginia, Aquifer characteristics.

Water use for the public supply in northern Upshur County, West Virginia exceeds the 1930 drought flow of its water source, the Buckhannon River. Three underground flooded coal mines near Buckhannon store about 1,170 acre-ft of water. This stored water, plus an additional 500 gal/min of groundwater infiltration into the mine, is enough to supply current public water needs of the area (1,500 gal/min) for 265 days, and projected needs (2,500 gal/min) for the year 2018 for about 135 days. This is also adequate enough for the year 2018 during droughts comparable to those in 1953 and 1930, for which 1900 gal/min and 2400 gal/min would be needed, respectively, to augment the surface-water source. Water from the flooded mines is chemically similar to water from nearby wells; however, nearby coal mining or pumpage from the mines may cause roof falls or subsidence, turbidity, changes in water quality, or leakage into or from the mines. More than 70 communities in

West Virginia use water from coal mines for public supply. The flooded coal mines near Buckhannon could supply the public-water supply needs of northern Upshur County for about 265 days, but the water will require treatment to remove dissolved substances. (USGS)
W90-07853

GEOHYDROLOGY AND GROUND-WATER QUALITY AT SELECTED SITES IN MEADE COUNTY, KENTUCKY, 1987-88.
Geological Survey, Reston, VA. Water Resources Div.
D. S. Mull, A. G. Alexander, and P. E. Schultz.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4108, Dec. 1989. 67p, 5 fig, 8 tab, 57 ref.

Descriptors: *Groundwater, *Groundwater pollution, *Karst hydrology, *Kentucky, *Water quality, Bacteria, Organic compounds.

Because of the vulnerability of karst aquifers to contamination and the use of groundwater as a water source by about 18,500 people, the U.S. Geological Survey conducted a 1-year study to characterize the quality of the water from carbonate aquifers of Mississippian age in the Meade county area, north-central Kentucky. Forty-nine sites, consisting of 12 springs and 37 wells, were sampled. Water was analyzed for major anions and cations, nitrates, trace elements, organic compounds, and fecal species of coliform streptococci and total coliform bacteria. Selected sites were sampled intermittently to define the seasonal variation in water quality. Except for fluoride and lead, the concentrations of the constituents analyzed were within the range expected from carbonate aquifers. The fluoride content exceeded the Federal drinking-water standard at 14 sites. The concentration of lead was 50 micrograms/liter which is the maximum contaminant level in one well. Total dissolved solids and hardness ranged from 100 to 2,200 and 20 to 1,100 mg/L, respectively. Gas chromatographic/flame ionization detection scans did not indicate elevated concentrations of organic compounds. Low levels of specific organic compounds were related to precipitation and the seasonal use of agricultural chemicals. The drinking-water standard for total coliform content was exceeded in water from 12 springs and 14 wells; 12 springs and two wells contained fecal species of coliform or streptococci bacteria. Statistical analyses indicated no relation between water quality and the geographic location of the sampling site. Seasonal variations in concentrations of total dissolved solids, hardness, and iron were observed. (USGS)
W90-07854

HYDROLOGY OF THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER, SOUTH-CENTRAL UNITED STATES—A PRELIMINARY ASSESSMENT OF THE REGIONAL FLOW SYSTEM.
Geological Survey, Little Rock, AR. Water Resources Div.
D. J. Ackerman.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4028, November 1988. 74p, 40 fig, 37 ref.

Descriptors: *Alluvial aquifers, *Arkansas, *Geohydrology, *Gulf Coastal Plain, *Louisiana, *Mississippi, *Missouri, Boundary conditions, Computer models, Flow system, Mississippi River Valley Alluvial Aquifer, Mississippi embayment aquifer system, Steady flow.

Data describing the aquifer framework and steady-state regional flow were assembled for the Mississippi River Valley alluvial aquifer north of Vicksburg, Mississippi. The aquifer is part of the Mississippi embayment aquifer system. The 60 to 140 ft thick alluvial aquifer grades from gravel at the bottom to fine sand near the top. It is overlain by the Mississippi River Valley confining unit, which consists of 10 to 50 ft of silts, clays, and fine-grained sands. Underlying units consist of alternat-

ing sands and clays corresponding to regional hydrogeologic units of the Mississippi embayment aquifer system. The three-layer finite difference model was used to simulate two-dimensional confined or unconfined steady-state flow for predevelopment and 1972. Preliminary analysis of predevelopment flow indicates that recharge to the alluvial aquifer was from underlying aquifers and the confining unit. Rivers accounted for almost all discharge. Pumpage from the alluvial aquifer for irrigation substantially changed regional flow direction toward depressions in the potentiometric surface. Recharge from rivers and the confining unit increased and recharge from underlying aquifers decreased. Discharge to underlying aquifers increased and discharge to rivers decreased. Recharge from the confining unit reached a maximum of 1.3 inch/year for large parts of the aquifer. Nearly all drawdown exceeding 20 ft was at two locations in Arkansas--the Grande Prairie region, and west of Crowleys Ridge. Model results indicate the importance of leakage from rivers and the confining unite to providing recharge to sustain large amounts of pumpage from the alluvial aquifer. (USGS)
W90-07856

ORGANIC CARBON AND THM FORMATION POTENTIAL IN KANSAS GROUNDWATERS.
Kansas Dept. of Health and Environment, Topeka. Bureau of Environmental Remediation.
For primary bibliographic entry see Field 5B.
W90-07895

EFFECT OF PH CONCENTRATION ON THE TRANSPORT OF NAPHTHALENE IN SATURATED AQUIFER MEDIA.
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W90-07904

CHARACTERIZATION OF A SANDY AQUIFER MATERIAL AT THE GRAIN SCALE.
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W90-07905

DISSOLVED GAS EVIDENCE FOR DENITRIFICATION IN THE LINCOLNSHIRE LIMESTONE GROUNDWATERS, EASTERN ENGLAND.
Department of Science (Geology Division), Anglia Higher Education College, Cambridge, CB1 1PT England.
For primary bibliographic entry see Field 5B.
W90-07977

METHOD FOR MODELING WATER TABLE AT DEBRIS AVALANCHE HEADSCARPS.
British Columbia Univ., Vancouver.
For primary bibliographic entry see Field 2J.
W90-07978

SHALLOW SEISMIC REFRACTION USED TO MAP THE HYDROSTRATIGRAPHY OF NUKUORO ATOLL, MICRONESIA.
Nebraska Univ.-Lincoln. Conservation and Survey Div.
J. F. Ayers.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 123-133, February 1990. 5 fig, 13 ref.

Descriptors: *Groundwater, *Hydrostratigraphy, *Micronesia, *Saline groundwater, *Seismology, Carbonate facies, Permeability, Saline water intrusion, Tidal pumping.

Results from a shallow seismic-fraction survey on Nukuoro indicate that the distribution of fresh and brackish groundwater on that atoll island is controlled by a three-dimensional mosaic of carbonate facies. Each facies is characterized by a distinct seismic velocity which is dependent on the grain size, composition, and abundance of carbonate cement. The refraction survey further indicates that the upper saturated zone is composed of

mostly unconsolidated sediments underlain by highly permeable, well-indurated limestone. The fresh-water lens and associated transition zone of fresh to saline groundwater occur within the upper consolidated sediments. Measurements of chloride-ion concentrations in water samples collected from sites across the island indicate an asymmetric fresh-water lens with the thickest part of the lens located near the lagoon shoreline. During the 1983 drought, saline water intruded into the island's central topographical depression where taro is cultivated. The intrusion was caused by tidal pumping (upward movement) of brackish water underlying a reef-flat plate, which forms a confining layer over a significant part of the island. (Author's abstract)
W90-07981

INFLUENCE OF GRID DISCRETIZATION ON THE PERCOLATION PROBABILITY WITHIN DISCRETE RANDOM FIELDS.
Notre Dame Univ., IN. Dept. of Civil Engineering.
S. E. Silliman.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 177-191, February 1990. 9 fig, 3 tab, 24 ref.

Descriptors: *Groundwater, *Model studies, *Percolation, *Stochastic models, Data processing, Grid discretization, Monte Carlo method.

Recent advances in the study of stochastic modeling of groundwater systems have shown that the stochastic behavior of a random system varies substantially with the dimension of the system. In this study, a Monte Carlo simulation was utilized in connection with the percolation theory on finite sized lattices to investigate the transition of the mean critical probability (as defined in percolation theory) within discretized random fields as the field geometry varies from two dimensions to three dimensions. It is shown that this mean critical probability is very sensitive to vertical discretization. Increasing the geometric complexity of a simulation grid from a one-layered, two-dimensional plant to a two-layered system, for example, decreased the probability for large grids from approximately 0.595 to 0.485. Increasing this complexity further to obtain a cubic grid geometry caused a decrease in the mean critical probability to approximately 0.315. Furthermore, it is demonstrated that the variation of the mean critical probability can be described by a simple scaling relationship. It is concluded that the complexity lost through reduced discretization in the third dimension cannot be regained through increased discretization in the remaining two dimensions. (Author's abstract)
W90-07985

SOURCES OF NITRATES IN FISSURE GROUNDWATER IN THE HUMID TROPICAL ZONE--THE EXAMPLE OF IVORY COAST (ORIGINE DES NITRATES DANS LES NAPPES DE FISSURES DE LA ZONE TROPICALE HUMIDE--EXAMPLE DE LA COTE D'IVOIRE).
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
For primary bibliographic entry see Field 5B.
W90-07988

GROUNDWATER DISCHARGE TO A HEADWATER VALLEY, NORTHWESTERN NEVADA, U.S.A.
Fish and Wildlife Service, Lakeview, OR.
B. R. Hill.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 265-283, February 1990. 3 fig, 6 tab, 39 ref.

Descriptors: *Groundwater movement, *Headwaters, *Nevada, *Snowmelt, *Surface-groundwater relations, Bedrock, Erosion, Fractures, Groundwater depletion, Hydraulic conductivity, Hydraulic head.

Field observations of groundwater flow were made during and following snowmelt in Spring 1985 in a small alluvial headwater valley in northwestern Nevada. Measurements of hydraulic heads

were made in wells and piezometers, and groundwater discharge from the gully was measured volumetrically. Horizontal and vertical hydraulic conductivities of meadow strata were determined with field and laboratory tests. Specific conductance of gully outflow was monitored and used to estimate components of groundwater discharge with a mass-balance technique. An approximate water balance was calculated based on measured snowmelt volume, precipitation, groundwater discharge, and water-table elevations. Results indicate that despite the low primary permeability of the rhyolitic bedrock, a large proportion of groundwater discharged to the gully consists of water moving through fractures or faults in bedrock. Erosion of the gully has removed relatively low-permeability alluvium that formerly restricted groundwater discharge from the meadow. Groundwater discharges in response to snowmelt recharge is now probably more rapid and of shorter duration than prior to erosion. (Author's abstract)
W90-07989

INDIRECT DETECTION OF SUBSURFACE OUTFLOW FROM A RIFT VALLEY LAKE.
British Geological Survey, Wallingford (England).
For primary bibliographic entry see Field 2H.
W90-07991

ORGANIC CONTAMINATION OF THE BIRMINGHAM AQUIFER, U.K.
Birmingham Univ. (England). School of Earth Sciences.
For primary bibliographic entry see Field 5B.
W90-07992

RADIOACTIVE HAZARD OF POTABLE WATER IN VIRGINIA AND MARYLAND.
George Mason Univ., Fairfax, VA. Center of Basic and Applied Science.
For primary bibliographic entry see Field 5C.
W90-08018

HANDBOOK OF GROUND WATER DEVELOPMENT.
Moss (Roscoe) Co., Los Angeles, CA.
For primary bibliographic entry see Field 4B.
W90-08140

GROUNDWATER DISCHARGE TESTS: SIMULATION AND ANALYSIS.
D. Clarke.
Elsevier, New York, New York. 1988. 375p.

Descriptors: *Aquifer testing, *Computer programs, *Groundwater discharge, *Model studies, *Pumping tests, *Simulation analysis, Computers, Geohydrology.

This book provides computer programming tools for the practicing geohydrologist. Emphasis is placed on utility rather than on theoretical rigor. All of the programs in this book are written in Turbo Pascal rather than in BASIC, and provide a tool for the simulation of groundwater discharge. These programs run on IBM-compatible PCs with a minimum of 250k memory available to the program. Several programs use color graphics and one program PLOTWTD uses a plotter. Useful, but not essential are a hard disk, a math co-processor, and 640k of RAM. The programs may be typed in from the book if they are not available to the user on disk. Each chapter describes one or more program(s), each of which has four parts: (1) the program from the users point of view; (2) a description by procedure and function; (3) a list of the key lines of the program; and (4) the program listing itself. (Lantz-PTT)
W90-08153

SEEPAGE, DRAINAGE, AND FLOW NETS.
For primary bibliographic entry see Field 8B.
W90-08154

LOGS OF WELLS AND BOREHOLES DRILLED DURING HYDROGEOLOGIC STUDIES AT LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300. JUNE 1, 1982-JUNE 30, 1988.
Brown and Caldwell, Pleasant Hill, CA.
For primary bibliographic entry see Field 7C.
W90-08155

COMPILATION OF HYDROLOGIC DATA FOR THE EDWARDS AQUIFER, SAN ANTONIO AREA, TEXAS, 1988, WITH 1934-88 SUMMARY.
Geological Survey, San Antonio, TX. Water Resources Div.
For primary bibliographic entry see Field 7C.
W90-08160

GROUND WATER MODELING IN MULTILAYER AQUIFERS: STEADY FLOW.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
M. M. Aral.
Lewis Publishers, Chelsea, Michigan. 1989. 114p. Included is one 5-1/4-inch floppy disk containing the computer program SLAM.EXE.

Descriptors: *Computer models, *Computer programs, *Groundwater management, *Groundwater movement, *Groundwater recharge, *Model studies, Aquifers, Leaky aquifers, Mathematical models.

In order to effectively monitor and manage aquifers subject to artificial recharge and analyze effects of changing pumping demands, it is necessary to predict the hydraulic response of an aquifer system under varied geohydrologic conditions. To accomplish this task on a regional scale, several mathematical-numerical models were developed for the study of main aquifer layers or simplified leaky aquifer systems. Although the main theory on multilayer aquifer analysis is available in the current literature, and several applications summarizing this theory were published by the author, the applications software supporting this theory has not been available to the user. This book is intended to serve as a bridge between theory and practice and provide a useful tool for geohydrologists, engineers, geologists, educators, and students. It includes a summary of basic theory, assumptions involved, and restrictions and limits of the model for multilayer aquifer analysis. The reader is expected to have a working knowledge of basic concepts of geohydrology in order to fully implement the computer code presented. The computer program given in this book is as general and simple to use as possible. Input data preparation can be very time-consuming, but in this computer code, data generation routines are included to minimize the time involved. An input data file format, rather than a menu-operated screen input format, is used to facilitate problem definition and accuracy of data input. The multilayer aquifer computer program discussed in this text is called the Steady Layered Aquifer Model (SLAM.EXE). The distribution disk accompanying this text contains several data files for case studies discussed in the text and a BASIC program (IDEAL.BAS), which may be used to plot the finite-element idealization of the aquifer under study. Procedures to implement these codes are explained in detail. (Lantz-PTT)
W90-08172

BOREHOLE SITING IN CRYSTALLINE BASEMENT AREAS OF NIGERIA WITH A MICROPROCESSOR-CONTROLLED RESISTIVITY TRAVERSING SYSTEM.
Ibadan Univ. (Nigeria). Dept. of Geology.
For primary bibliographic entry see Field 7B.
W90-08186

ANALYTICAL SOLUTION FOR STEADY-STATE FLOW BETWEEN AQUIFERS THROUGH AN OPEN WELL.
Notre Dame Univ., IN. Dept. of Civil Engineering.
S. Silliman, and D. Higgins.
Ground Water GRWAAP, Vol. 28, No. 2, p 184-190, March/April 1990. 8 fig, 12 ref. U.S. Geological Survey Department of the Interior Award No. 14-08-0001-G1477 and the National Science Foundation Grant No. ENG-87-12598.

Descriptors: *Aquifer systems, *Groundwater movement, *Path of pollutants, *Vertical flow, Aquifer characteristics, Confined aquifers, Flow rates, Open wells, Steady flow, Transmissivity.

Vertical communication between aquifers via open wells may cause migration of a chemical plume from a contaminated aquifer into a water-supply aquifer. Hence, quantifying the rate of flow through such wells may aid either in identifying likely transport paths or in designing a migration monitoring system. A steady-state solution was developed which allows quantification of the volumetric flow rate which will occur within an inactive well which fully penetrates two confined aquifers. The solution is an adaptation of the Thiem solution and includes a well-loss term based on the square of the flow rate. The solution for flow between a confined aquifer and an unconfined aquifer is also presented. Based on three examples concerning hypothetical flow problems, it was shown that the well-loss term is insignificant unless both aquifers have high transmissivities and the well-loss coefficient is large. The most significant assumptions required for application of these solutions are that: (1) there is steady-state flow, (2) knowledge exists regarding the head at some radial distance from the open well, (3) knowledge exists regarding the effective radius of the well within both aquifers, and (4) the open well fully penetrates both aquifers. (Author's abstract)
W90-08187

CHARACTERIZATION OF TRANSMISSIVE FRACTURES BY SIMPLE TRACING OF IN-WELL FLOW.
Whitman Companies, Inc., East Brunswick, NJ.
A. Michalski, and G. M. Klepp.
Ground Water GRWAAP, Vol. 28, No. 2, p 191-198, March/April 1990. 7 fig, 15 ref.

Descriptors: *Aquifer characteristics, *Borehole geophysics, *Geologic fractures, *Groundwater movement, *Monitoring wells, *Tracers, *Transmissivity, Conductivity, Flow pattern, Fracture permeability, Path of pollutants, Saline water.

Under-exploration of complex hydrogeologic settings may lead to the occurrence of short-circuiting internal flows in monitoring wells. Susceptible settings include fractured formations with large thickness and monotonous lithology. The occurrence of internal flow may distort flow pattern and induce contaminant migration. Monitoring data from the affected wells may be misinterpreted if the flow is unaccounted for. In order to identify and measure well bore flow in several deep monitoring wells at a site, a technique of in-well tracing was used. The vertical movement, dispersion, and dilution of an injected saline slug was tracked by periodic electrical conductivity logging. Combining internal flow measurements with baseline conductivity and temperature logs provided estimates of the quality and origin of water entering well bores from major transmissive fractures. Identified locations of these fractures coincided with locations of larger fractures seen on video logs; only a few fractures were significant for the flow. Relative distributions of heads and fracture permeabilities in a well with internal flow could be evaluated easily, but determination of their absolute values would require measurement of static heads. In data quality, cost, and feasibility, the in-well slug tracking compares favorably with conventional fracture characterization methods, such as coring, packer permeability testing, flowmeter and other specialized geophysical logging. (Author's abstract)
W90-08188

MODELING OF GROUND-WATER CONTAMINATION CAUSED BY ORGANIC SOLVENT VAPORS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
C. A. Mendoza, and T. A. McAlary.
Ground Water GRWAAP, Vol. 28, No. 2, p 199-206, March/April 1990. 5 fig, 2 tab, 18 ref.

Descriptors: *Aeration zone, *Boundary conditions, *Groundwater pollution, *Mathematical models, *Model studies, *Organic pollutants, *Path of pollutants, Capillarity, Diffusion, Drinking water, Groundwater quality, Infiltration rate, Numerical analysis, Permeability, Plug flow, Sensitivity analysis, Surface-groundwater relations, Water pollution sources.

Mathematical models are used to evaluate the potential for groundwater contamination resulting from vapor transport of volatile organic solvents in the unsaturated zone. A two-dimensional numerical model for density-driven flow and transport of vapors shows that trichloroethylene (TCE) vapors can be expected to spread rapidly from a residual source above an unconfined aquifer in an unsaturated, sandy deposit. Sensitivity analyses show that the shape of the vapor plume is particularly sensitive to the ground surface boundary condition and the material permeability. The shape of the vapor plume is insensitive to the mass flux by diffusion through the capillary fringe, although the flux may be significant in terms of groundwater quality because the drinking water standard is very low. The vapor plume simulations and a plug flow infiltration model are used to calculate a source function for a groundwater transport model in order to estimate the potential for groundwater contamination. Groundwater simulations show that an impermeable surface cover could reduce the flux of contaminants to the aquifer by preventing infiltration through the vapor plume. However, for the conditions modeled, significant groundwater contamination can be expected to occur regardless of whether the ground surface is covered or not. Contaminants can reach the saturated zone from a residual source either by liquid-phase diffusion through the capillary fringe or by migrating as a vapor beyond the lateral limits of a cover and subsequently dissolving and being flushed to the saturated zone by infiltration. (Author's abstract)
W90-08189

INTEGRATED APPROACH TO IDENTIFYING THE SALINITY SOURCE CONTAMINATING A GROUND-WATER SUPPLY.
Civil and Environmental Consultants, Inc., Pittsburgh, PA.
For primary bibliographic entry see Field 5B.
W90-08190

COMPATIBLE SINGLE-PHASE/TWO-PHASE NUMERICAL MODEL: 2. APPLICATION TO A COASTAL AQUIFER IN MEXICO.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
A. Rivera, E. Ledoux, and S. Sauvagnac.
Ground Water GRWAAP, Vol. 28, No. 2, p 215-223, March/April 1990. 18 fig, 2 tab, 7 ref.

Descriptors: *Coastal aquifers, *Flow models, *Groundwater movement, *Model studies, *Numerical analysis, *Saline-freshwater interfaces, Aquifer characteristics, Diffusivity, Freshwater, Piezometers, Pump wells, Steady flow.

The analysis of the freshwater/saltwater interface either in steady-state or in transient conditions can no longer be omitted from studies in the design and planning of groundwater systems in coastal areas. One of the principal difficulties found in modeling coastal aquifers involves the efficient and accurate simulation of the movement of the saltwater/freshwater front. The application of a numerical model to a coastal aquifer was performed, including the simulation of single-phase and two-phase fluid flow. The single-phase part of the model solves the diffusivity equation and helps to identify certain parameters of the aquifer and to simulate the flow field (freshwater) under different conditions. The two-phase part of the model solves the partial differential equations describing the motion of saltwater and freshwater separated by a sharp interface. The model was calibrated using the observed piezometry of the aquifer for the freshwater flow field. Simulations were made for both steady-state

and unsteady-state conditions to establish the position and movement of the interface under different schemes of pumping. Results show that the model reproduces very accurately the flow field of freshwater. It identifies the potential salt-water intrusion (upconing) into some of the pumping wells, thus helping in the identification of optimal pumping schemes. (Author's abstract)
W90-08191

OASIS: A GRAPHICAL DECISION SUPPORT SYSTEM FOR GROUND-WATER CONTAMINANT MODELING.
Groundwater Services, Inc., Houston, TX.
For primary bibliographic entry see Field 5B.
W90-08192

HYDROCARBON THICKNESS FLUCTUATIONS IN MONITORING WELLS.
Utah Water Research Lab., Logan.
M. W. Kemblowski, and C. Y. Chiang.
Ground Water GRWAAP, Vol. 28, No. 2, p 244-252, March/April 1990. 13 fig, 8 ref.

Descriptors: *Groundwater pollution, *Hydrocarbons, *Monitoring wells, *Organic pollutants, *Path of pollutants, Aeration zone, Flow pattern, Groundwater movement.

Hydrocarbon thickness measurements in monitoring wells are used to estimate the hydrocarbon volume in the subsurface and to evaluate the efficiency of hydrocarbon recovery. It is commonly assumed that the formation hydrocarbon thickness is linearly related to the measured one. However, field data frequently show hydrocarbon thickness fluctuations that are not related to either hydrocarbon recovery or its release. These fluctuations may be related to hydrocarbon/groundwater interface elevation changes, and can be explained by two mechanisms: (1) difference in the residual saturation of hydrocarbons entrapped below and above the 'interface,' and (2) preferred flow of the liquids through the monitoring well. (Author's abstract)
W90-08194

CHEMICAL EVOLUTION OF GROUND WATER IN THE MILK RIVER AQUIFER, CANADA.
National Water Well Association, Dublin, OH.
For primary bibliographic entry see Field 2K.
W90-08195

SAMPLING RADIUS OF A POROUS CUP SAMPLER: EXPERIMENTAL RESULTS.
Wisconsin Univ.-Madison. Dept. of Soil Science.
R. D. Morrison, and B. Lowery.
Ground Water GRWAAP, Vol. 28, No. 2, p 262-267, March/April 1990. 7 fig, 1 tab, 23 ref.

Descriptors: *Aeration zone, *Groundwater pollution, *Instrumentation, *Sampling, *Soil water pollution, *Tracers, Injection, Laboratory methods, Soil water.

In recent years, porous cup samplers have been used to detect contaminants in the unsaturated zone of an aquifer system. Laboratory experiments were conducted to examine the radius of soil (sand) sampled by a porous cup sampler. This soil radius was defined by the detection of potassium bromide (KBr) in a sample when KBr was injected at horizontal distances of 5, 10, 15, 30, and 45 cm from the sampler. For quasi-static soil moisture conditions, the relation between the soil radius as defined by the arrival time (t) of KBr at the sampler (evacuated with a constant vacuum of 70 kPa) after it was injected at a distance (x) was described by t = 1.4 multiplied by x to the 2.3 power. As expected, desaturation occurred most rapidly near the sampler (0-5 cm). The amount of KBr collected on a mass balance basis was greatest when KBr was injected near the sampler and decreased with injection distance. The injection of KBr into the soil at a prescribed distance from the sampler was a better method for predicting the soil radius for a given time than change in matrix potential of the soil. (Author's abstract)
W90-08196

FACTORS CONTROLLING THE CONCENTRATION OF METHANE AND OTHER VOLATILES IN GROUNDWATER AND SOIL-GAS AROUND A WASTE SITE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 5B.
W90-08204

FIELD STUDIES OF THE EFFECTS OF THE CAPILLARY FRINGE ON STREAMFLOW GENERATION.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
A. S. Abdul, and R. W. Gillham.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 1-18, December 1989. 10 fig, 9 ref.

Descriptors: *Capillarity, *Shallow aquifers, *Streamflow, *Surface-groundwater relations, Aquifer systems, Field tests, Flow nets, Hydrographs, Infiltration capacity, Precipitation, Pressure head, Rainfall rate, Rainfall-runoff relationships, Seepage, Storage capacity, Storm water, Stream discharge, Surface runoff, Water table rise.

Two field experiments were conducted to investigate the effect of the capillary fringe on surface water-groundwater interactions and on streamflow generation in a shallow water table aquifer. The results from both experiments showed that the water table adjacent to the stream, where the capillary fringe extended to or close to ground surface, responded rapidly to the precipitation events due to the initially low storage capacity of the medium. This rapid and large response led to the development of a water table mound on both sides of the stream and flow nets showed that the mound resulted in the discharge of pre-event water through the seepage faces that developed on both sides of the stream. Furthermore, the mound contributed to the discharge of event water in that precipitation falling on the seepage faces was transported directly to the stream as overland flow. A further contribution of event water to the stream occurred as surface runoff from areas upslope of the seepage faces, where the pressure head was zero, but the rainfall rate exceeded the infiltration capacity of the soil. Under the conditions of the study, the results support the commonly recognized mechanisms of streamflow generation, including the partial area, variable-source-area overland flow, and variable-source-area subsurface flow concepts. The relative contribution of these mechanisms to stormflow appeared to be determined by the response of the capillary fringe. The amount of pre-event water in the discharge determined by the tracer method of hydrograph separation showed good agreement with the instantaneous pre-event discharge hydrograph determined from flow nets. (Author's abstract)
W90-08214

INFLUENCE OF PORE DISTRIBUTION ON THE HYDRAULIC CONDUCTIVITY OF SOME SWEDISH TILLS.
Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Geology.
B. B. Lind.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 41-53, December 1989. 10 fig, 27 ref.

Descriptors: *Glacial aquifers, *Groundwater movement, *Hydraulic conductivity, *Pore size, *Saturated flow, *Till, Correlation analysis, Geologic control, Geologic fractures, Interstitial water, Permeameters, Pressure head, Sampling, Steady flow.

The relationship between pore size distribution and hydraulic conductivity was studied on 42 undisturbed till samples. The samples were taken horizontally with known geographical orientation. The hydraulic conductivity was measured with steady upward flow in a constant head permeameter. The results show a random pattern in the relationship between the total porosity and the hydraulic conductivity. A significant positive correlation was obtained between the hydraulic conductivity and the porosity in the interval 95-30 micrometers,

whereas no such relationship could be established between the hydraulic conductivity and coarser pores. This could be explained by the fissility structure in the till matrix which forms continuous micro-fissures, about 50-100 micrometers in width, whereas the coarser pores are more or less isolated. (Author's abstract)
W90-08216

HYDROGRAPH SEPARATION IN A SMALL ALPINE BASIN BASED ON INORGANIC SOLUTE CONCENTRATIONS.
Colorado Univ., Boulder. Inst. of Arctic and Alpine Research.
For primary bibliographic entry see Field 2E.
W90-08219

GROUNDWATER REGIME OF THE VALLEY OF MEXICO FROM HISTORIC EVIDENCE AND FIELD OBSERVATIONS.
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Geofisica.
J. Durazo, and R. N. Farvolden.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 171-190, December 1989. 6 fig, 2 tab, 42 ref.

Descriptors: *Aquifer characteristics, *Groundwater resources, *History, *Hydrological regime, *Mexico, *Paleohydrology, *Subsidence, Alluvial deposits, Clays, Closed basins, Confined groundwater, Earthquakes, Evaporation, Geohydrologic boundaries, Geologic control, Geologic history, Groundwater movement, Groundwater recharge, Lakes, Mountains, Pumping, Saline water, Springs, Transpiration, Valleys.

In Mexico, historical accounts, documents and native legends provide information of past hydrogeological conditions. The Valley of Mexico is a graben structure, closed hydrologically and covered by a series of lakes at the time of the Conquest. Groundwater recharge occurs in the mountains that surround the Valley. Thick lacustrine clays cover the Valley floor and artesian conditions once prevailed. Large springs of potable water were numerous at the edge of the Valley, and where permeable aquifers pinch out. Thermal mineral springs occur along lineaments thought to be fractures in the rocks below the alluvial fill. The entire Valley floor and the lowest slopes of the mountains were zones of groundwater discharge. All water discharge from the Valley was by evaporation and transpiration, and salts accumulated in the lake-water and in the clays. The main lakes were nonpotable and the Aztecs, and later the Spanish colonials, depended on groundwater from the springs. Salt production from brines was an important industry in the Aztec society as it is today. The occurrence of the freshwater ahuehuete tree where earthquake damage is worst suggests an upward migration of fresh groundwater through fractures in the clay that have been opened by seismic response. The water table and the capillary fringe are near ground surface over the lowlands; flooding has always been a problem to societies that occupy the Valley. Groundwater gradients have been reversed by aquifer pumping that began in 1847, so that the direction of flow is downward, allowing contaminants to migrate downward. Heavy pumping has also caused drainage and consolidation of the lacustrine clays, and consequently land subsidence. (Author's abstract)
W90-08224

SEASONAL FLUCTUATION IN DELTA N15 OF GROUNDWATER NITRATE IN A MANTLED KARST AQUIFER DUE TO MACROPORE TRANSPORT OF FERTILIZER-DERIVED NITRATE.
Indiana Univ., Bloomington. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W90-08225

COLIPHAGES AS INDICATORS OF HUMAN ENTERIC VIRUSES IN GROUNDWATER.
American Society for Microbiology, Washington, DC.
For primary bibliographic entry see Field 5A.

W90-08237

GROUND WATER TRANSPORT OF HYDRO-PHOBIC ORGANIC COMPOUNDS IN THE PRESENCE OF DISSOLVED ORGANIC MATTER.
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5B.
W90-08239

ESTIMATION OF GROUNDWATER RE-CHARGE FROM SPRING HYDROGRAPHS.
State Hydraulic Works, Ankara (Turkey). Geotechnical Services and Groundwater Div.
N. Korkmaz.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 2, p 209-217, April 1990. 8 fig, 3 tab, 7 ref.

Descriptors: *Aquifer characteristics, *Groundwater recharge, *Hydrographs, *Recharge, *Turkey, Aquifers, Data interpretation, Karst, Mediterranean, Springs.

The amount of groundwater recharge to an aquifer depends on the amount of precipitation and its seasonal distribution, the air temperature, the land use, and other factors; direct measurements of the recharge components are not possible. Because of these factors, determining the recharge to aquifers is a difficult problem in all water resource studies. The aim of this study was a synthesis of results which can be obtained by an analysis if a spring discharge. This study suggests that the Kirkgoz springs discharging from karstified limestone about 30 km north of Antalya city are the most important water resource. Mesozoic karstic limestone covering the catchment area of the Kirkgoz springs constitute the essential recharge area of the groundwater. The average discharge coefficient of this aquifer is approximately 0.00405/day while the dynamic reserve change during the period 1974-1982 is 59.9 million cu m. The average annual recharge volume and discharge volume for the same period are 493.3 million cu m and 486.5 million cu m, respectively. (Miller-PTT)
W90-08271

ECONOMIC ASPECTS OF GROUND-WATER WITHDRAWAL PERMIT TRANSFERS.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
J. W. Eheart, and J. P. Barclay.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 282-303, March/April 1990. 10 fig, 1 tab, 14 ref, append.

Descriptors: *Economic aspects, *Groundwater use, *Permits, *Simulation analysis, Crop yield, Illinois, Irrigation, Irrigation permits, Weather forecasting.

The economic properties of three different permitting options for regulating groundwater withdrawals were estimated by computer simulation of the economic return for irrigation of corn. The three regulatory options consist of withdrawal limitations in the form of groundwater pumping permits allocated in proportion to overlaying land area with: no trading of permits; trading of long-term (over years) permits; and trading of both long-term and short-term (within year) permits. Seven scenarios representing different combinations of regulations and weather and crop-yield predictability were simulated for farm crops in heavily irrigated areas of Kankakee and Mason counties, Illinois. Alternative assumptions regarding weather predictability were: no knowledge at all; complete knowledge of future weather and accurate crop-yield modeling (i.e., response to weather conditions and quantity of applied irrigation water); and knowledge of past weather and accurate crop-yield modeling, but no knowledge of future weather. The results indicated that a considerable increase in economic efficiency may be realized from long-term permit trading and improving the accuracy of weather and crop-yield forecasting. The value of long-term permit trading was found to diminish in the presence of accurate crop-yield forecasting and

was smaller yet if accurate weather prediction was available as well. (Author's abstract)
W90-08280

IMPACT OF DIFFUSE NITRATE POLLUTION SOURCES ON GROUNDWATER QUALITY--SOME EXAMPLES FROM CZECHOSLOVAKIA.
Stavebni Geologie, Prague (Czechoslovakia). Hydrogeology Dept.
For primary bibliographic entry see Field 4C.
W90-08295

GROUNDWATER POLLUTION BY NITRATES FROM LIVESTOCK WASTES.
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrogeologii i Inzhenerdoi Geologii, Moscow (USSR).
For primary bibliographic entry see Field 5B.
W90-08296

CHEMICAL SUBSTANCE TRANSPORT IN SOILS AND ITS EFFECT ON GROUNDWATER QUALITY.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 5B.
W90-08297

HYDROGEOLOGICAL ROLE OF AN AQUI-TARD IN PREVENTING DRINKABLE WATER WELL CONTAMINATION: A CASE STUDY.
Milan Univ. (Italy). Dipt. di Scienze della Terra.
For primary bibliographic entry see Field 5B.
W90-08300

APPLICATIONS OF NUMERICAL METHODS TO SIMULATE THE MOVEMENT OF CON-TAMINANTS IN GROUNDWATER.
Shandong Univ., Jinan (China). Environmental Science Center.
For primary bibliographic entry see Field 5B.
W90-08301

MODELING MULTIPHASE MIGRATION OF ORGANIC CHEMICALS IN GROUNDWATER SYSTEMS--A REVIEW AND ASSESSMENT.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-08302

HYDROCHEMICAL PROCESSES IN GROUNDWATER-DISCHARGE PLAYAS, CEN-TRAL AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 2K.
W90-08328

REGIONAL AQUIFER SYSTEMS OF THE UNITED STATES: AQUIFERS OF THE MID-WESTERN AREA.
Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. 238p. Edited by L. A. Swain and A. Ivan Johnson.

Descriptors: *Aquifer systems, *Groundwater movement, *Groundwater resources, *Regional Aquifer Systems Analysis, Aquifers, Conferences, Geochemistry, Geohydrology, Groundwater management, Symposium.

This is the fifth book in the series of the U.S. Geological Survey's Regional Aquifer System Analysis Program. The following regions are covered in this publication: Northern Midwest Regional Aquifer; Michigan Basin Regional Aquifers; Ohio-Indiana Regional Aquifer; Central Midwest Regional Aquifer; and the High Plains Regional Aquifer. Geochemistry, groundwater flow, geohydrology, and groundwater management are dis-

cussed with respect to these aquifer systems. (See W90-08401 thru W90-08413) (Lantz-PTT)
W90-08400

CAMBRIAN-ORDOVICIAN REGIONAL AQUI-FER SYSTEM IN THE NORTHERN MID-WEST--A SUMMARY.
Geological Survey, Madison, WI.
H. L. Young, R. J. Mandle, A. L. Kontis, and D. I. Siegel.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 5-37, 15 fig, 1 tab, 43 ref.

Descriptors: *Aquifer characteristics, *Aquifer systems, *Cambrian-Ordovician Aquifer System, *Regional Aquifer Systems Analysis, Groundwater recharge, Hydraulic head, Leaky aquifers, Saline water.

The Cambrian-Ordovician aquifer system contains very productive sandstone and carbonate aquifers throughout an area of about 161,000 square miles in the northern Midwest. The aquifer system is the primary source of water over most of its area of occurrence, except for Indiana, central and southern Illinois, and western Iowa, where the aquifer system contains saline water. Computer simulations of regional groundwater flow show that the Cambrian-Ordovician aquifer system functions as a leaky-artesian system in which movement of groundwater is controlled partly by the internal confining units. In the northern outcrop area, where the uppermost confining unit is absent, unconfined conditions prevail. Much of the recharge in upland areas discharges to streams through local flow systems. The remainder of the recharge moves slowly into the regional flow system. Saline water in the basins and reduction in intrinsic permeability restricts movement of freshwater into the deeper parts of the basins, forcing flow upward through confining units. Principal regional discharge areas are the Mississippi and Missouri Rivers, the Illinois and Michigan basins, and Lake Michigan. Simulated natural predevelopment recharge and discharge for the Cambrian-Ordovician aquifer system balance at 352 million gallons per day. Development of the aquifer system began in the 1860's near Lake Michigan; heads were 186 feet above Lake Michigan at Milwaukee and 130 feet at Chicago. Large-scale pumping has produced head declines of as much as 375 and 900 feet at Milwaukee and Chicago, respectively. The total head decline in the St. Peter-Prairie du Chien-Jordan aquifer in the Twin Cities by 1980 was only 90 feet because the aquifer is unconfined. Most of the eastern two-thirds of Iowa, where the aquifer system is tightly confined, is characterized by a head decline greater than 50 feet. (See also W90-08400) (Author's abstract)
W90-08401

SIMULATION OF GROUND-WATER FLOW IN THE CAMBRIAN-ORDOVICIAN AQUIFER SYSTEM IN THE CHICAGO-MILWAUKEE AREA OF THE NORTHERN MIDWEST.
Geological Survey, Madison, WI.
H. L. Young, A. J. MacKenzie, and R. J. Mandle.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 39-72, 15 fig, 43 ref.

Descriptors: *Aquifer systems, *Cambrian-Ordovician Aquifer System, *Groundwater movement, *Model studies, *Regional Aquifer Systems Analysis, *Simulation analysis, Aquifers, Chicago, Computer models, Confined aquifers, Groundwater mining, Milwaukee.

The Cambrian-Ordovician aquifer system has been an important source of water for the Chicago and Milwaukee metropolitan areas for more than 100

years. Groundwater pumpage has produced deep cones of depression that have affected the potentiometric surface over most of northeastern Illinois and southeastern Wisconsin. Decline of the potentiometric surface has exceeded 900 ft in the Chicago area and 425 ft in the Milwaukee area. A digital model of this system was developed to simulate three-dimensional groundwater flow in a region larger than that encompassing the Chicago and Milwaukee metropolitan areas. The aquifer system was modeled as three aquifer layers (primarily sandstone), each of which is overlain by confining units of shale, siltstone, and dolomite. Simulation of steady-state, predevelopment flow indicates that groundwater flow directions are from the subcrop area of the Cambrian-Ordovician aquifer system in the west and toward Lake Michigan in the east. Simulation of development of the Cambrian-Ordovician aquifer system from 1865 through 1985 shows the growth of two large, coalescing cones of depression positioned at Chicago and Milwaukee. Simulated directions of groundwater flow are from the subcrop of the Cambrian-Ordovician aquifer system in the west, to the deep cones of depression at Chicago and Milwaukee. Transient simulations show that induced recharge has increased and that natural discharge has decreased. The rate of recharge from the glacial drift increased to 0.79 inch/yr. The rate of recharge through the Maquoketa confining unit, where it subcrops or is very thin, increased to 0.57 inch/yr, and discharge in this area remained approximately the same at 0.1 inch/yr. The downward flow rate through the Maquoketa confining unit, beneath the Silurian-Devonian aquifer, increased slightly to 0.0078 inch/yr. (See also W90-08400) (Lantz-PTT)
W90-08402

GEOCHEMISTRY OF THE SANDSTONE AQUIFER, SOUTHERN WISCONSIN.
Syracuse Univ., NY. Dept. of Geology.
D. I. Siegel, and K. F. Begor.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 73-82, 6 fig, 20 ref.

Descriptors: *Geochemistry, *Regional Aquifer Systems Analysis, *Sandstone Aquifer, *Water chemistry, *Wisconsin, Bicarbonates, Calcium, Dolomite, Groundwater chemistry, Groundwater movement, Groundwater recharge, Lake Michigan, Magnesium, Sulfates.

Groundwater in the Sandstone Aquifer of southern Wisconsin changes from a calcium-magnesium-bicarbonate where the aquifer is unconfined in central Wisconsin, to calcium-sulfate-bicarbonate type water down major flow paths where the aquifer is confined. Delta S-34 in sulfate ranges from -3.6 parts per thousand (ppt) in the unconfined portion to a nearly constant +20 ppt where confined. The isotopically-enriched sulfate was probably emplaced in the aquifer as vertical leakage of calcium-sulfate type waters, from evaporitic Silurian rocks under Lake Michigan during Pleistocene glaciation, when flow paths likely were from east to west. Dedolomitization may have occurred in the aquifer when the calcium-sulfate type waters mixed with the pre-existing calcium-magnesium-bicarbonate type water. This process is suggested by decreasing pH and undersaturation of the groundwater with respect to dolomite with increasing sulfate concentrations. The age of the groundwater, based on carbon-14 analyses, increases from a maximum of about 2,000 years BP in the unconfined zone to over 35,000 years BP downgradient near Lake Michigan. (See also W90-08400) (Author's abstract)
W90-08403

GEOHYDROLOGIC FRAMEWORK AND GROUND-WATER FLOW IN THE MICHIGAN BASIN.
Fishbeck, Thompson, Carr and Huber, Inc., Ada, MI.
R. J. Mandle, and D. B. Westjohn.
IN: Regional Aquifer Systems of the United States:

Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 83-109, 15 fig, 51 ref.

Descriptors: *Aquifer systems, *Geohydrology, *Groundwater movement, *Michigan Basin, *Regional Aquifer Systems Analysis, Dissolved solids, Glacial aquifers, Groundwater chemistry, Groundwater quality, Model studies, Saline water, Simulation analysis, Surface-groundwater relations.

Mississippian and Pennsylvanian sedimentary rocks and Quaternary sediments in the Michigan Basin form a regional aquifer system of three aquifer units and two intervening confining units. Devonian and Mississippian shales form a low-permeability basal confining unit for the regional groundwater flow system. Mississippian and Pennsylvania sandstones and Quaternary glacial deposits supply approximately 188 million gallons/day to municipalities in the 29,000 sq mi study area. Availability of adequate amounts of potable groundwater is limited in many areas by the presence of saline groundwater (dissolved solids concentration of 1,000 to 100,000 mg/L). Saline water underlies the entire Lower Peninsula of Michigan at various depths. Brine (dissolved-solids concentration > 100,000 mg/L) is found in the deeper parts of the Mississippian and Pennsylvania sandstones in the center of the Michigan Basin. It is possible to simulate the direction of regional groundwater flow toward the Great Lakes and the center of the basin in the three aquifers that underlie the uplands in the north-central and south-central parts of the Lower Peninsula. Computer simulation showed that the proglacial Grand River flowed across the Lower Peninsula and created a topographic and water table depression. Model simulations inferred that these areas are likely to be groundwater discharge regions, because of the presence of saline groundwater near land surface in the lowlands. Steady-state simulations of regional groundwater flow suggest that the presence of saline groundwater in regional discharge areas result from the upwelling of deep saline groundwater within the regional groundwater flow system. (See also W90-08400) (Author's abstract)
W90-08404

APPLICATION OF GEOPHYSICS IN THE DELINEATION OF THE FRESHWATER/SALINE-WATER INTERFACE IN THE MICHIGAN BASIN.
Geological Survey, Lansing, MI.
D. B. Westjohn.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 111-134, 22 fig, 1 tab, 13 ref.

Descriptors: *Geophysics, *Groundwater chemistry, *Michigan Basin, *Regional Aquifer Systems Analysis, *Saline-freshwater interfaces, Aquifer characteristics, Aquifer systems, Borehole geophysics, Brines, Porosity, Resistivity.

The presence of shallow saline groundwater (< 30 M deep) in the Michigan Basin is known from chemical analyses of groundwater collected in some areas of the basin. However, the position of the freshwater/saline-water interface is unknown for most of the State. Data from borehole geophysical logs are used to delineate the altitude of the base of freshwater within the area where Mississippian and younger rocks underlie Pleistocene glacial deposits. The character and thickness of the transition zone and the location of the top of the first brine-bearing unit also are interpreted from electric (resistivity) and porosity logs. In areas where geophysical logs are sparse, vertical electrical-resistivity soundings are used to estimate the depth to the first brine-bearing sandstone and to map the vertical extent of freshwater. Geophysical logs and vertical electrical-resistivity soundings indicate that freshwater transects the glacial-deposits/bedrock interface. Areas are defined where the

freshwater section exceeds 300 meters in thickness. These areas are predominated by glaciofluvial deposits that overlie freshwater-bearing Pennsylvania sandstones. The thickness of the transition zone ranges from a few meters to greater than 150 meters, and it consists of Pennsylvanian sandstones and shaly sands that contain saline water. The shallowest brine-bearing sandstones generally are confined to the Upper-Mississippian rock sequence, but Pennsylvanian sandstones also contain brine in some areas. (See also W90-08400) (Author's abstract)
W90-08405

OHIO-INDIANA CARBONATE-BEDROCK AND GLACIAL REGIONAL AQUIFER SYSTEM ANALYSIS--PLAN OF STUDY.
Geological Survey, Columbus, OH.
E. F. Bugliosi.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 135-148, 8 fig, 18 ref.

Descriptors: *Aquifer systems, *Data acquisition, *Geohydrology, *Glacial aquifers, *Indiana, *Ohio, *Project planning, *Regional Aquifer Systems Analysis, Classification, Geochemistry, Groundwater management, Groundwater quality, Surveys.

Unconsolidated, quaternary glacial deposits and carbonate bedrock of Silurian and Devonian age comprise the major aquifers in a 32,000 sq mi area in western Ohio and eastern Indiana. These deposits have been designated for study as part of the U.S. Geological Survey's Regional Aquifer System Analysis (RASA) program. The purpose of the Ohio-Indiana RASA study is to define the geohydrology, geochemistry, and geologic framework of the Silurian and Devonian carbonate bedrock and the overlying glacial sediments by systematically describing the regional groundwater flow patterns and characterizing the water quality of the study area. The 5-year project began in 1988. The scope, objectives, approach, and organization of the work elements are presented in this study plan. The approach will be to compile existing geohydrologic, water quality and remotely sensed satellite data; collect additional geohydrologic and water quality data from existing wells or wells that may be drilled during the study; and compile current land-use and water-use data. A geographic information system will be used as a data-base-management tool and for spatial analysis and presentation of much of the data. (See also W90-08400) (Author's abstract)
W90-08406

GEOHYDROLOGY OF REGIONAL AQUIFER SYSTEMS IN CRETACEOUS AND OLDER ROCKS UNDERLYING THE CENTRAL UNITED STATES.
U.S. Geological Survey, c/o National Drilling Company, P.O. Box 15287, El Ain, United Arab Emirates.
D. C. Signor, and J. L. Imes.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 149-163, 4 fig, 13 ref.

Descriptors: *Aquifer systems, *Geohydrology, *Groundwater movement, *Regional Aquifer Systems Analysis, Aquifers, Bedrock, Groundwater quality, Hydraulic head, Model studies, Saline water.

Three regional flow systems are the basis for describing the geohydrology of bedrock aquifers of the central United States. The study area extends from the foothills of the Rocky Mountains in Colorado to the Mississippi River in eastern Missouri and from South Dakota to the Ouachita, Arbuckle,

and Wichita Mountains of Arkansas and Oklahoma. The Great Plains aquifer system is composed of Lower Cretaceous sandstone and is confined by the Great Plains confining system composed of Upper Cretaceous shale. The Western Interior Plains aquifer system, composed of Lower Paleozoic rocks, contains a saline water flow system and is laterally adjacent to the freshwater-bearing Ozark Plateaus aquifer system, also composed of Lower Paleozoic rocks. The Western Interior Plains aquifer system and Ozark Plateaus aquifer system are confined by the Western Interior Plains confining system, composed of Upper Mississippian through Jurassic rocks. A three-dimensional model of groundwater flow in the three regional aquifer systems generally matched measured and calculated hydraulic head and flow data for the systems. The Ozark Plateaus aquifer system is characterized by a well developed circulation, whereas the other two regional aquifer systems are characterized by near-stagnant conditions in many areas. (See also W90-08400) (Authors's abstract) W90-08407

GEOHYDROLOGY AND HYDROCHEMISTRY OF THE OZARK PLATEAUS AQUIFER SYSTEM.
Geological Survey, Rolla, MO.
J. L. Imes.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 165-178, 7 fig, 1 tab, 19 ref.

Descriptors: *Geochemistry, *Geohydrology, *Groundwater chemistry, *Ozark Plateaus Aquifer System, *Regional Aquifer Systems Analysis, Aquifer characteristics, Groundwater movement, Groundwater quality, Hydraulic conductivity.

An analysis of the groundwater hydrology of the mainly freshwater-bearing carbonate terrane of the Ozark Plateaus province and nearby parts of the Interior Plains, Mississippi Alluvial Plain, and Arkansas Valley was undertaken as part of the U.S. Geological Survey Central Midwest Regional Aquifer-System Analysis. Three distinct hydrologic systems are described for the study area: the Western Interior Plains confining system, the Ozark Plateaus aquifer system, and the Basement confining unit. The Ozark aquifer is the thickest aquifer in the study area and provides most of the water to municipal, industrial, and domestic wells. Yields from deep wells open to the Ozark aquifer may exceed 1,000 gallons/minute. Shallower wells that penetrate only a few hundred feet of the less permeable formations may yield < 25 gallons per minute. A 3-dimensional groundwater flow model was constructed to analyze regional predevelopment groundwater flow in the Ozark Plateaus aquifer system. A new methods of simulating groundwater recharge and stream-aquifer interaction in regional scale models was devised using independent estimates of: (1) recharge to the water table; (2) baseflow and hydrologic characteristics of springs and streams; and (3) topographic features. The effect is to redistribute and generally decrease recharge to model cells to represent recharge to the deeper regional groundwater flow system. The model estimated lateral hydraulic conductivity of the Springfield Plateau aquifer is 0.00025 ft/sec. Model estimates of the lateral hydraulic conductivity of the Ozark aquifer ranges from 0.00001 ft/sec in the south to 0.0008 ft/sec in the north and east. The lateral hydraulic conductivity of the St. Francois aquifer is 0.00016 ft/sec near the St. Francois Mountains and decreases to 0.00008 ft/sec elsewhere. (See also W90-08400) (Lantz-PTT) W90-08408

GEOHYDROLOGY OF THE GREAT PLAINS AQUIFER SYSTEM, CENTRAL UNITED STATES.
Geological Survey, Lawrence, KS.
J. O. Helgesen, and R. B. Leonard.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 179-190, 7 fig, 5 ref.

Descriptors: *Aquifer systems, *Geohydrology, *Great Plains Aquifer System, *Regional Aquifer Systems Analysis, Dissolved solids, Flow rates, Groundwater movement, Groundwater quality, Hydraulic conductivity, Hydraulic properties, Model studies, Porosity.

The Great Plains aquifer system (Dakota Sandstone and associated strata) varies considerably in lithology, depth of occurrence, hydraulic properties, and resource development (water and petroleum) throughout 170,000 sq mi of Nebraska, Colorado, Kansas, and adjacent areas. Porosity, hydraulic conductivity, and flow rates generally decrease from eastern and southern outcrop areas toward western basins. Hydraulic head distribution indicates a west-to-east gradient of regional flow. Water quality is related mainly to environment of deposition, with limited modification by post-depositional flow patterns. Water in much of the aquifer system is brackish (1,000 to 10,000 mg/L dissolved solids). Flow model simulations indicate a predevelopment steady-state flow through the system of about 340 cu ft/sec. Regional hydraulic head declines in response to oil and gas development have been several hundreds of feet; declines resulting from the most intensive freshwater withdrawals have been several tens of feet. Rates of water withdrawal greatly exceed the natural recharge, but the aquifer system is a potential long-term source of water if some storage depletion is tolerated. The system also offers potential for liquid-waste injection and geothermal-energy development. (See also W90-08400) (Author's abstract) W90-08409

HIGH PLAINS REGIONAL AQUIFER--GEOHYDROLOGY.
Geological Survey, Denver, CO.
J. B. Weeks, and E. D. Gutentag.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 191-206, 7 fig, 8 ref.

Descriptors: *Aquifer systems, *Geohydrology, *High Plains Regional Aquifer, *Regional Aquifer Systems Analysis, Groundwater budget, Groundwater irrigation, Groundwater movement, Groundwater recharge, Groundwater use.

The High Plains aquifer underlies 174,000 sq mi in parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. About 20% of the irrigated land in the United States is in the High Plains, and about 30% of the groundwater used for irrigation in the United States is pumped from the High Plains aquifer. During 1980, about 170,000 wells pumped almost 18 million acre-ft of water to irrigate nearly 14 million acres. The High Plains aquifer is a water-table aquifer consisting mainly of near-surface sand and gravel deposits of Tertiary and Quaternary age. The Tertiary Ogallala Formation, which underlies about 80% of the High Plains, is the principal geologic unit in the aquifer. The maximum saturated thickness of the aquifer is about 1,000 feet and the average saturated thickness is about 200 feet. Groundwater generally flows from west to east at an average rate of about 1 ft/day and discharges naturally to streams and springs, and by evapotranspiration in areas where the water table is near land surface. Precipitation is the principal source of recharge to the aquifer. Recharge rates range from 0.024 in/yr in parts of Texas to 6 in/yr in areas of dune sand in Kansas and Nebraska. About 3.25 billion acre-ft of drainable water is stored in the aquifer. Approximately 65% of the water in storage is in Nebraska, and 12% is in Texas. New Mexico, the State with the smallest water resource in the High Plains, has only 1.5% of the volume of water in storage. Pumpage has caused extensive water level declines in the aquifer. Since irrigation began in the High

Plains, water levels have declined more than 10 feet in 50,000 sq mi and > 50 ft in 12,000 sq mi. Water level declines of as much as 200 feet have occurred since irrigation started and the volume of water in storage in the aquifer has decreased by 166 million acre-ft. About 70% of the depletion has occurred in Texas; about 16% of the depletion has occurred in Kansas. (See also W90-08400) (Author's abstract) W90-08410

HIGH PLAINS REGIONAL AQUIFER--ESTIMATING 1980 GROUND-WATER PUMPAGE FOR IRRIGATION.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 4B.
W90-08411

HIGH PLAINS REGIONAL AQUIFER--MAPPING IRRIGATED AGRICULTURE USING LANDSAT DATA.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 7C.
W90-08412

SIMULATED EFFECTS OF FUTURE PUMPAGE ON THE HIGH PLAINS AQUIFER, WEST-CENTRAL UNITED STATES.
Geological Survey, Denver, CO.
J. B. Weeks, and R. R. Luckey.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 225-235, 4 fig, 1 tab, 6 ref.

Descriptors: *Groundwater budget, *Groundwater mining, *High Plains Regional Aquifer, *Regional Aquifer Systems Analysis, *Simulation analysis, Groundwater depletion, Groundwater level, Groundwater movement, Groundwater recharge.

The High Plains aquifer underlies about 174,000 sq mi in parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. It is the primary source of water for a major agricultural area. The U.S. Geological Survey developed groundwater flow models to project changes in water levels, saturated thickness, and well yields from 1980 to 2020. The total estimated pumpage from the High Plains aquifer between 1980 and 2020 was 628 million acre-ft including 113 million acre-ft in the southern High Plains, 158 million acre-ft in the central High Plains, and 357 million acre-ft in the northern High Plains. The total estimated pumpage from the High Plains aquifer prior to 1980 as 411 million acre-ft, including 210 million acre-ft in the southern High Plains, 94 million acre-ft in the central High Plains, and 107 million acre-ft in the northern High Plains. Between 1980 and 2020, water level declines in most of the High Plains will exceed 10 ft; and declines are projected to exceed 100 ft in areas totaling about 15,500 sq mi in parts of all states, except South Dakota and Wyoming. Projected saturated thickness in 2020 exceeds 100 ft in 72,500 sq mi (42%) and 200 ft in 37,600 sq mi (22%) of the High Plains. The projected 2020 saturated thickness averages 155 ft for the entire High Plains, 36 ft for the souther High Plains, 104 ft for the central High Plains, and 217 ft for the northern High Plains. Lower water levels and saturated thickness will reduce well yields. The largest percentage changes occur where the projected water level change from 1980 to 2020 is large and the 1980 saturated thickness was small. Declines in well yield were projected to be least in the northern High Plains and greatest in the southern High Plains. (See also W90-08400) (Lantz-PTT) W90-08413

FIBER OPTIC METHODS FOR VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER.
Tufts Univ., Medford, MA. Dept. of Civil Engineering.

For primary bibliographic entry see Field 7B.
W90-08515

KARST HYDROLOGY: CONCEPTS FROM THE MAMMOTH CAVE AREA.
Van Nostrand Reinhold, New York. 1989. 346p. Edited by William B. White and Elizabeth L. White.

Descriptors: *Geohydrology, *Karst, *Karst hydrology, *Kentucky, *Mammoth Cave, Carbonate rocks, Caves, Flood flow, Geologic fractures, Green River, Groundwater movement, Hydraulic properties, Sinkholes.

Scattered widely over the Earth, karst landscapes are often pocked and pitted areas of sinkholes, limestone towers, steep-sided hills, underground drainage, and caves. For the most part formed on carbonate rocks such as limestones or dolomites. The south-central Kentucky karst, explored in this book, is a superb example of a shallow, intensely karsted, carbonate aquifer unit. The 12 original papers collected here draw on the 30-year program of the Cave Research Foundation, on the survey and cartography of the giant cave systems, and on many individual hydrological and geomorphological studies. Also included is the program of the National Park Service carried out by the National Park geologist. The book presents an introduction to the karst hydrology of the Mammoth Cave area, as well as detailed contributions on its geohydrology, subsurface drainage, and water budget and physical hydrology. Other topics covered are: flood hydrology; chemical hydrology; cave systems south of the Green River; caves and drainage north of the Green River; hydraulic geometry of cave passages; and fracture control on conduit development. There is also a report on stratigraphic and structural control of cave development and groundwater flow, plus a geomorphic history of the Mammoth Cave system. (See W90-08554 thru W90-08554) (Lantz-PTT)
W90-08542

INTRODUCTION TO THE KARST HYDROLOGY OF THE MAMMOTH CAVE AREA.
Pennsylvania State Univ., University Park. Dept. of Geosciences.
W. B. White.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 1-13, 1 fig, 1 tab, 37 ref.

Descriptors: *Geohydrology, *Karst hydrology, *Kentucky, *Mammoth Cave, Aquifers, Carbonate rocks, Caves, Flow pattern, Groundwater movement, Karst, Sinkholes.

Scattered widely over the Earth is a rather peculiar landscape known as 'karst.' Karst landscapes are often pocked and pitted lands of sinkholes, limestone towers and steep-sided hills, underground drainage, and caves. Most karst is formed on carbonate rocks such as limestones or dolomites, sometimes on gypsum, and more rarely on rocks of other lithologies. Karst landscapes can include underground rivers. Underground water in karst, unlike groundwater in nonkarstic rocks, is concentrated in natural pipes dissolved from the solid rock. When water tables are lowered, these water-filled conduits drain, dry out, and fill with air, and some develop entrances that become the caves accessible to human exploration. Sometimes developed to dramatic extents, sometimes visible only to the trained professional eye, karst terrains make up, according to several estimates, about 15% of the Earth's land surface. Of these, few have attracted more attention than the doline karst and the great limestone caves that lie under and around Mammoth Cave National Park in south-central Kentucky. The most characteristic feature of karst terrain is the concentration of water flow in underground solution conduits. This means that there are two or more parts of the aquifer with very different response times. Because of the input to the karst groundwater system is through sinkholes and sinking streams, and because of the open character of the aquifer and lack of thick soil covers, karst systems are susceptible to pollution. Sources of pollutants include industrial and hydro-

carbon wastes; sinking polluted surface streams; sinkhole dumps; agriculturally derived nitrates; herbicide and pesticide residues; highway spills; and leaking sewer lines, pipelines, and storage tanks. Almost any imaginable source of pollution can be transmitted rapidly to the subsurface and into the groundwater system. (See also W90-08542) (Lantz-PTT)
W90-08543

HYDROGEOLOGY OF THE SOUTH-CENTRAL KENTUCKY KARST.
Nevada Univ. System, Las Vegas. Water Resources Center.
J. W. Hess, S. G. Wells, J. F. Quinlan, and W. B. White.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 15-63, 27 fig, 2 tab, 42 ref.

Descriptors: *Geohydrology, *Karst hydrology, *Kentucky, *Surface-groundwater relations, Barren River, Caves, Conductivity, Green River, Groundwater movement, Groundwater recharge, Permeability, Porosity, Springs.

The main groundwater body in the south-central Kentucky karst occurs in the cavernous St. Louis, Ste. Genevieve, and Girkin limestones. The overall permeability of carbonate rock is the sum of three contributions: (1) primary porosity and permeability that is due to the presence of communicating pore spaces; (2) permeability that is due to the three-dimensional network of joints, fractures, and bedding-plane partings; and (3) permeability due to cavernous openings. Primary porosity of the Ste. Genevieve Limestone is 3.3%, and the coefficient of permeability is 0.0016 L/day/sq mm, as determined from core samples. Specific capacities of wells drilled in the St. Louis Limestone range from 70 to 8700 L/min/m of drawdown. The outlet points for the water collected in the karst aquifer are a series of springs along Green River and Barren River. Some springs are very large implying a large catchment; others are small suggesting discharge of water from local sources. The physical manifestation of springs on Green River ranged from small subtle notches under trees on the riverbank to resurgence streams up to 1000 m long. Some of the springs flowed from open cave mouths, while others had rise pools ranging from 1 m to 100 m in diameter. The alluviated springs are developed below river level and have rise pools that are bed at depth approximately 10 m below pool stage of the river. The regional springs have relatively high discharge and specific conductance. They receive their major recharge from the Sinkhole Plain, which is capable of providing the necessary catchment area to maintain the high discharge and provides the longer flow path and residence time necessary to account for the high conductance. For that portion of the Pennyroyal Plateau east of Barren River, but not draining to Green River, 67 sq km are drained by approximately seven springs with a total low-flow discharge of 0.12 cu m/sec. The remaining 360 sq km of area drains to four alluviated outlets at one point known as the Graham Springs complex. The total low-flow discharge for this spring complex is approximately 0.55 cu m/sec. The Graham Springs complex discharges into a common valley forming a resurgence river about 360 m long. (See also W90-08542) (Lantz-PTT)
W90-08544

SUBSURFACE DRAINAGE IN THE MAMMOTH CAVE AREA.
National Park Service, Mammoth Cave, KY.
J. F. Quinlan, and R. O. Ewers.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 65-103, 17 fig, 47 ref.

Descriptors: *Groundwater movement, *Karst hydrology, *Kentucky, *Mammoth Cave, *Subsurface drainage, Caves, Flow profiles, Geohydrology, Springs.

In the Mammoth Cave area of Kentucky the groundwater basins discharge primarily at a spring or group of springs at or near a base-level stream.

The springs are fed by a system of dendritic or trellised conduits that increase in size and order as they decrease in number in the downstream direction. There might be, and probably is, some seepage discharge at rivers, but it has not been detected or studied. The Bear Wallow Groundwater basin is the largest groundwater basin in the Mammoth Cave area, about 500 sq km. Its most significant features are: Hidden River groundwater sub-basin and associated cave system, near Horse Cave; distributaries; and shared headwaters. Heavy-metal-laden effluent from the Horse Cave Sewage Treatment Plan has been discharged into the ground for almost 20 years. Study of the dispersal of this effluent showed that it travels 1.6 km northeast to Hidden River Cave and then 6-8 km north to where it is discharged at as many as 46 springs at 16 locations along an 8-km reach of Green River. Hydrodynamic and geochemical models suggest that the tributary pattern of the caves should give way to one of distributaries, similar in function to those in the delta region of major surface rivers, but relatively larger and different in origin. There are four concepts of groundwater movement that have been recognized previously in other karst terrains, but are now described in the Mammoth Cave area better and in more detail than anywhere else. They are: (1) distributary flow; (2) shunting of water by high-level overflow routes; (3) shared headwaters; and (4) location of all major stream caves in troughs on the potentiometric surface and, likewise, association of all major troughs with axes of trunk drainage in the subsurface. (See also W90-08542) (Lantz-PTT)
W90-08545

WATER BUDGET AND PHYSICAL HYDROLOGY.
Nevada Univ. System, Las Vegas. Water Resources Center.
For primary bibliographic entry see Field 2A.
W90-08546

FLOOD HYDROLOGY.
Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-08547

CHEMICAL HYDROLOGY.
Nevada Univ. System, Las Vegas. Water Resources Center.
For primary bibliographic entry see Field 2K.
W90-08548

CAVE SYSTEMS SOUTH OF THE GREEN RIVER.
T. A. Brucker.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 175-188, 1 tab, 18 ref.

Descriptors: *Caves, *Geohydrology, *Karst, *Karst hydrology, *Kentucky, *Mammoth Cave, Groundwater movement.

This chapter offers a description of some of the large cave systems south of the Green River and, in particular, the Mammoth Cave system itself, which, with more than 500 km of surveyed passage contains some of the longest fragments of conduit known anywhere. The main components of the Mammoth Cave system are: (1) the Upper Salts Avenue Trunk, the largest passage in the Mammoth Cave system. It is a large canyon, extensively modified by breakdown, and filled with secondary sediments; (2) the Main Cave Trunk, which includes many of the large passages seen in the developed portions of Mammoth Cave. Main Cave, and to a greater extent its upstream continuation, Kentucky Avenue, are extensively modified by breakdown and filled with sediments; (3) Deer Park Avenue, the least exposed low-gradient trunk. More is known about its principal tributary system, Big Avenue/Cleveland Avenue, a tributary that perhaps had significant recharge in the Chester Cuesta. Deer Park Avenue is 80 sq km in cross section, and < 1 km of passage is known.

Group 2F—Groundwater

Numerous portions of Deer Park trunk are breakdown-free, however the passage is aligned with a fracture zone (often mapped as a fault) north toward Green River; (4) Grand Avenue, the best exposed of the low-gradient trunks. The upstream component, Grand Avenue in Colossal Cave, also has the greatest volume: 100 sq km. Two primary levels meander from Colossal Dome to Sandstone Tumbledown, the point at which the upper level is terminated by breakdown. Grand Avenue has a canyon shape which, although modified by breakdown, is not modified to the extent of other passages discussed. Sediments in the Pearly Pools Route contain a large pebble fraction, which suggest that high-stream velocities were present in this conduit; and (5) Frost Avenue, which lies within the Joppa Member of the Ste. Genevieve Limestone near the same elevation as Grand Avenue, has many apparent tributary branches and is often intersected by vertical shafts or modified by canyons. The westernmost 3 km of passage are low gradient. Breakdown terminates Frost Avenue several kilometers from Green River, and no passages have been discovered beyond that might correlate. (See also W90-08542) (Lantz-PTT)
W90-08549

CAVES AND DRAINAGE NORTH OF THE GREEN RIVER.
A. I. George.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 189-221, 13 fig, 1 tab, 56 ref.

Descriptors: *Caves, *Geohydrology, *Geomorphology, *Green River, *Karst hydrology, *Kentucky, *Literature review, Groundwater movement, Karst.

Geomorphology and lithology control the distribution of caves and karst development north of the Green River in Edmonson, Hart, Green, and Taylor counties, Kentucky. Unique to this locality is the presence of pseudokarst and paleokarst. The northern portion of the central Kentucky karst covers approximately 333 sq km. Territorially, the northern area is partially bounded by three base-level streams and two major escarpments: Green River on the south, Nolin River to the west, Bacon Creek and the Chester Escarpment on the north, and Little Brush Creek and the Muldraugh Escarpment to the east. The northern frontier is controlled by a major lithologic and surface drainage divide situated between Green River and Bacon Creek. This divide extends along the crest of the Brush Creek Hills from the headwaters of Little Brush Creek on the dip slope of the Muldraugh Cuesta and then westward to Nolin River. Lithologic rock types often control the position of cave passages and texture of karst landforms. Carbonates are more susceptible to solution than clastics; and some carbonates are more soluble than other carbonates. Shale, siltstone, and chert tend to act as aquitards or barriers to the solution of carbonates. This literature review chapter presents studies conducted in the caves and karst north of Green River, specifically in the following areas: (1) Boiling Springs Hollow; (2) Lynn Camp Creek; and (3) Hilly Country. Other discussions focus on: (1) subsurface tracer experiments conducted north of the Green River; (2) pseudokarst; and (3) pseudokarst and the destruction of the Brownsville Channel. (See also W90-08542) (Lantz-PTT)
W90-08550

HYDRAULIC GEOMETRY OF CAVE PASSAGES.
Pennsylvania State Univ., University Park. Dept. of Geosciences.
W. B. White, and G. H. Deike.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 223-258, 23 fig, 2 tab, 22 ref.

Descriptors: *Caves, *Geohydrology, *Groundwater movement, *Hydraulic geometry, *Karst hydrology, *Kentucky, Channel flow, Channels, Conduits, Flow pattern, Green River, Karst, Model studies.

There are two competing sets of factors that control the original solutional shapes of the natural drainpipes that make up the Mammoth Cave conduit system of Kentucky. One set comprises the spatial variations in the rates of solution of the bedrock caused by the distribution and geometry of joints and bedding planes, by the variations in solubility of the limestone, and by the distribution of such lithologic features as shale beds, dolomite beds, sandy layers, and chert nodules. The second set comprises the variation in rates of solution caused by the shifting flow regimes of moving water. If flow velocities are low, the passage tends to be etched into a complex shape controlled by structural and lithologic factors and we speak of an etching geometry or structure-controlled geometry. If the rate of solution varies with flow velocity, the shape of the passages will be modified to accommodate the flow pattern and we speak of a hydraulic geometry. An aquifer model has been developed which proposes that a system of conduits carries most of the groundwater from the recharge area to springs on Green River. The cave passages are seen as abandoned conduits. The passages can be analyzed for the same sort of properties that are associated with surface stream channels. The comparison of the conduits of limestone aquifers with surface streams must be tempered by the additional complication that many conduits were created by water that filled them completely (pipe flow), whereas others were formed by streams of water with a free-air surface (channel flow). The distinction between pipe flow and open-channel flow is central to the hydraulic geometries of conduit systems. Some aspects of the hydraulic geometry that might be compared between surface channels and cave conduits include: (1) channel width/channel depth characteristics; (2) sinuosity; (3) braiding; (4) ordered branching ratios; and (5) distinct catchment area/discharge relationships. These comparisons are developed in some detail in this chapter. (See also W90-08542) (Lantz-PTT)
W90-08551

FRACTURE CONTROLS ON CONDUIT DEVELOPMENT.
G. H. Deike.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 259-291, 14 fig, 8 tab, 14 ref.

Descriptors: *Conduits, *Geohydrology, *Groundwater movement, *Hydraulic fracturing, *Karst hydrology, *Kentucky, *Mammoth Cave, Caves, Flow pattern, Geologic formations, Geologic fractures, Geologic joints, Karst, Limestone, Permeability.

Groundwater in the limestone of the Mammoth Cave system of Kentucky is transmitted through solution conduits that are developed along planes of secondary permeability. The groundwater must integrate continuous flow paths using bedding partings and joints and fractures. Joints are sparse and short. Major sets include northeast joints, which are planar and often in swarms. The northeast set is rarely followed by cave passages and often ignored. Fracture traces show less well-defined orientation patterns than joints, but are most developed in the direction of the southeast-northwest joint set, which is the direction of many cave passages. The joints that influence the development of the conduits are most commonly located in the bed immediately above the bedding parting, which is the primary path for water movement. Often this influence results in a short, straight length of conduit parallel to the joint direction; however, longer reaches of conduit that trend in the joint directions, but are not straight, are also developed. Passages in the caves are observed to follow joints or groups of joints, sometimes en echelon. The aquifer has somewhat greater permeability in the direction of the major joint sets, which direct groundwater flow locally. Most individual joints are limited to one or a few beds and do not interconnect. The result is that water seeking a through path must use the bedding planes. A considerable portion of the length of the caverns is not straight and shows no evidence of fracture control. Fractures that the initial passage crossed without notable effects continued to be ignored, except for solution pocketing extending into the fractures for distances usually < 30 cm. In some parts of the caves no joints are seen. In all such parts of the system, openness and surface features of the bedding and local structures most influenced the passage route, and hydraulic factors might have had more influence than in better jointed areas. The canyon passages show less joint influence than the tubes. The route followed by a canyon is somewhat joint directed because the tube whence the incision began was partly so directed. But during incision the hydraulic properties of the stream take over and produce a meandering pattern. Most vertical movement of water is downdip along bedding, but the vertical shafts at the edge of the caprock carry recharge directly down into the aquifer. The shafts are often located originally along vertical joints, but continue to develop downward through unjointed beds. (See also W90-08542) (Lantz-PTT)
W90-08552

STRATIGRAPHIC AND STRUCTURAL CONTROL OF CAVE DEVELOPMENT AND GROUNDWATER FLOW IN THE MAMMOTH CAVE REGION.
State Univ. of New York Coll. at Oneonta. Dept. of Earth Sciences.
A. N. Palmer.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 293-316, 10 fig, 11 ref.

Descriptors: *Geohydrology, *Groundwater movement, *Karst hydrology, *Kentucky, *Mammoth Cave, Caves, Flow pattern, Groundwater recharge, Karst, Mapping, Piezometric head, Vadose water.

It is not possible in such low-dip regions as found in the Mammoth Cave system of Kentucky, to use regional dip or surface geology to explain the orientation of cave passages. It is necessary to measure the dip of the controlling beds or partings within the actual area, with data points spaced no farther apart than the passage meanders. The local dip varies greatly from bed to bed because of variations in stratal thickness. In places where the mean dip is steeper, these irregularities would have little effect on groundwater flow patterns. Interpretation of cave origin--vadose or phreatic--involves more than the simple distinction between canyon passages and tubes. Although precise mapping is required to do so, the distinction between vadose and phreatic origin can best be determined by the relationship to the stratal dip. Ideally, downdip canyons change downstream into tubes having no consistent downdip trend, which is commonly oriented nearly along the strike. This transition zone, or 'piezometric limit', occurs where gravitational flow changes to flow in which the gravitational influence is offset to varied degrees by the downward increase in pressure within the phreatic zone. The elevation of the piezometric limit in each major passage provides a major clue to its geomorphic history. The great percentage of dip-oriented passages in the Mammoth Cave system shows that at least half of its passages, including some of the largest, are of vadose origin. Perching of groundwater flow above base level is unusually strong in the Mammoth Cave area. Although much of the descent of vadose passages takes place within the first few hundred meters, where shafts cluster along the axes of dry valleys and along ridge flanks, perching of vadose passages has been observed to extend for distances as great as several kilometers. Thus, the prevalent interpretation of vadose water descending straight down to the water table from its point of infiltration is far from accurate. Strike-oriented tubes illustrate the principle that the width of the initial openings far outweighs the hydraulic gradient in controlling the path of greatest efficiency in the phreatic zone. These openings, which developed at the contemporary base level, are the primary paths of groundwater flow, and they do not represent diversion from primary dip-oriented tubes as the result of new outlets developing in the strike direction. (See also W90-08542) (Lantz-PTT)
W90-08553

GEOMORPHIC HISTORY OF THE MAMMOTH CAVE SYSTEM.

State Univ. of New York Coll. at Oneonta. Dept. of Earth Sciences.
A. N. Palmer.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 317-337, 10 fig, 1 ref.

Descriptors: *Geologic history, *Geomorphology, *Karst hydrology, *Kentucky, *Mammoth Cave, Caves, Geohydrology, Karst.

If examined independently, neither the evolutionary history of a cave system nor that of the surrounding karst landscape can be interpreted so thoroughly as when a combined study is made of both. Relict cave patterns contain a much more precise record of hydrologic and geomorphic changes than any erosional surface features, but unless they are related to the surface landscape, many of the subterranean clues cannot be properly evaluated. Events hundreds of kilometers distant can sometimes have a profound effect on cave origin. Now that such a close correlation has been made with surface features, solutional caves can be interpreted more boldly in the future. From hydrologic standpoint, it is useful to examine the evolution of a complex system like Mammoth Cave to help understand the behavior of karst aquifers, even those that are inaccessible. Interpretation of the geomorphic history of the Mammoth Cave system requires reconstructing flow paths from passages that have been segmented by breakdown and fill since their origin. Their downstream continuation to the Green River is easily inferred in most cases, but their upstream continuation and recharge areas are more difficult to deduce. In general, it is possible to interpret the size of the recharge area from the size of the passage and the indicators of flow velocity within the passages. Although recharge to a given passage can be from several disparate sources, the major source is usually clear from the location of areas of exposed limestone at or above the altitude of the passage. Projection of known passages in the updip direction helps to determine the original source areas for water. (See also W90-08542) (Lantz-PTT)
W90-08554

NEED TO UPDATE GROUND WATER POLLUTION CONTROL STRATEGIES--A TECHNICAL BASIS AND HISTORICAL PERSPECTIVE.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W90-08560

EFFECT OF CLIMATE VARIABILITY AND CHANGE ON GROUNDWATER IN EUROPE.
Aarhus Amtskommune (Denmark). Groundwater Dept.
R. Thomsen.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 486-500, 11 fig, 10 ref.

Descriptors: *Climatic changes, *Europe, *Global warming, *Groundwater recharge, *Water supply, Air temperature, Denmark, Evaporation, Forecasting, Model studies, Precipitation, Research priorities, Transpiration, Water resources management.

In Europe groundwater is the most important freshwater resource for public water supply and industry. An analysis of European rainfall shows that rainfall varies with time, and in Denmark studies have shown that groundwater responds to climatic variation. The potential evapotranspiration in Europe is between 500 and 700 mm per year, while in much of Europe the annual rainfall is between 500 and 800 mm. Nearly all the summer rainfall evaporates; however, evaporation in the winter months is very low. Therefore, winter rainfall is the most important source of groundwater recharge. The GISS-model used to predict future changes in temperature and rainfall suggests that winter rainfall will increase in northern and central Europe as a result of climatic changes. If the model is correct, the water industry will get more groundwater for abstraction. However, using a simple groundwater recharge model that takes into account evaporation, root-zone capacity and vegetation, it is predicted that southwest Scandinavia, western and northeast France as well as Belgium can expect a decrease in groundwater recharge. This could have catastrophic effects for the local water industry. Water resource planning and future monitoring of the water balance and water quality must be based on hydrological models and the use of long time-series. Basic research on climatic change is of great and immediate practical importance for economic development in Europe. (See also W90-08565) (White-Reimer-PTT)
W90-08602

MULTIANNUAL VARIATIONS OF GROUNDWATER IN FINLAND DURING THE YEARS 1962-1989.
National Board of Waters, Helsinki (Finland). Water Research Inst.
J. Souveri, and T. Ahlberg.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 501-510, 6 fig, 2 tab, 9 ref.

Descriptors: *Climatic changes, *Finland, *Geohydrology, *Global warming, *Groundwater, *Groundwater recharge, Climates, Evaporation, Groundwater level, Hydrologic data, Precipitation, Soil types.

In temperate and humid environments, where annual precipitation invariably exceeds the annual potential evaporation, groundwater is recharged mainly by precipitation. Important factors which explain many changes in groundwater level are the degree of saturation, effective porosity, permeability and the distance which the infiltrating water has to travel to reach the groundwater table. Changes in groundwater level during the years 1962-1989 were examined at 29 observation sites in Finland for different soil types and climatological conditions. Long-term variations in groundwater level usually reflect a long-term rhythm in weather conditions. Statistical analyses were used to find out the periodicity and trend of the time series. Observations of groundwater level fluctuations over many years have shown the existence of long period variations, which reveal the multiennual irregular characteristics of inflows. At some stations there is a tendency for the random variation in rainfall to be stronger than the seasonal or annual variation with the result that the seasonal variations in groundwater levels are not as large as multiannual variations. The observation series of 27 years are too short to show the cyclic pattern or trend of the groundwater level to be statistically significant at certain climatological conditions or soil types. (See also W90-08565) (White-Reimer-PTT)
W90-08603

IMPACT OF CLIMATE CHANGE ON GROUNDWATER RECHARGE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
M. L. Sharma.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 511-520, 2 fig, 1 tab, 16 ref.

Descriptors: *Australia, *Climatic changes, *Global warming, *Groundwater recharge, *Soil-water-plant relationships, Aquifers, Land use, Model studies, Precipitation.

A mechanistic model, considering soil-plant-atmosphere interactions, was applied to simulate recharge rates beneath an annual grassland, and a perennial pine plantation, growing on sandy soil profiles representative of the Swan Coastal Plain of Western Australia. The sensitivity of the recharge (R) predicted by the model to changes in rainfall (P) was evaluated for a period of twelve months using measured daily rainfall and its variation. Simulations showed that recharge was modified by a much larger proportion than rainfall, and this was greatly influenced by land use. For example a +/-20% change in P modified R by +/-30% beneath the grassland and by +/-120% beneath the pine plantation. The depth of rooting in relation to the water table had a significant effect on such modifications. These results indicate that the expected climate changes will result in reduced sustainable yield for the Gnangara Mound which will affect the management of groundwater resources, and will affect current and future abstraction for public supply, water use by private bores for domestic and agricultural purposes, and maintenance of lakes and swamps. Since climate-induced recharge reductions are strongly dependent on land use, it is imperative to have knowledge of expected recharge and discharge under different land use types and conditions. (See also W90-08565) (White-Reimer-PTT)
W90-08604

2G. Water In Soils

SOIL PHYSICS.
Commonwealth Scientific and Industrial Research Organization, Adelaide (Australia). Div. of Soils.
T. J. Marshall, and J. W. Holmes.
Cambridge University Press, New York. 1988. 374p.

Descriptors: *Soil physics, *Soil properties, *Soil water, *Soil-water-plant relationships, Evaporation, Groundwater recharge, Saline soils, Salinity, Solute transport.

This textbook gives a comprehensive account of soil physics with emphasis on field applications for students and research workers engaged in water resources studies, and soil and plant sciences. The book gives an account of how water influences the physical properties of soils, such as stability of structure and ease of tillage; how plants absorb water from soils; how water from rain or irrigation enters the soil and flows through it to contribute to streamflow or to flow in artificial drains; how soluble salts may be transported to regions of accumulation where saline soils develop; and how the evaporation rate from the land surface is influenced by soil water supply, the nature of the plant cover and the evaporative power of the atmosphere. (Lantz-PTT)
W90-07555

EFFECTS OF ACCESS TUBE MATERIAL AND GROUT ON NEUTRON PROBE MEASUREMENTS IN THE VADOSE ZONE.
Metcalf and Eddy, Inc., Santa Barbara, CA.
For primary bibliographic entry see Field 7B.
W90-07600

SIMPLE ITERATIVE METHOD FOR THE SIMULTANEOUS DETERMINATION OF SOIL HYDRAULIC PROPERTIES FROM ONE-STEP OUTFLOW DATA.
Agricultural Coll. of Athens (Greece). Lab. of Agricultural Hydraulics.
J. D. Valiantzas, and P. G. Kerkides.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 143-152, January 1990. 13 fig, 1 tab, 22 ref, append.

Descriptors: *Hydraulic properties, *Soil moisture retention, *Soil physical properties, *Soil water, Mathematical analysis.

The inverse problem of identifying soil physical parameters from transient flow data has recently gained a new impetus due to the data requirements of numerical solutions to the transport equation. Assuming a Brooks and Corey family of moisture retention curves and a volumetric water content power hydraulic conductivity function, the parameter identification problem is solved with reasonable accuracy and simplicity, through the analysis of one-step outflow data. One-step outflow experiments are simple, easily performed in the laboratory, and can be performed on either disturbed or undisturbed soil samples. Additional information regarding the moisture retention curve may improve the results. The method does not require a numerical solution of the flow initial boundary value problem, and when tested against numerical

Group 2G—Water in Soils

and experimental outflow data gives very satisfactory results. (Tappert-PTT)
W90-07646

SENSITIVITY ANALYSIS OF FLOW IN UNSATURATED HETEROGENEOUS POROUS MEDIA: THEORY, NUMERICAL MODEL, AND ITS VERIFICATION.

Princeton Univ., NJ.
Z. J. Kabala, and P. C. D. Milly.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 593-610, April 1990. 11 fig, 2 tab, 44 ref, append. USGS, Department of Interior, Grant 1408-0001-G1138.

Descriptors: *Infiltration, *Mathematical models, *Soil water, *Unsaturated flow, Heterogeneity, Moisture transport, Porous media, Richards equation, Spatial variation.

Sensitivity analysis is one of the tools available for analyzing the effects of parameter uncertainty and soil heterogeneity on the transport of moisture in the unsaturated similar porous media. Direct differentiation of the discretized Richards equation with respect to parameters defining spatial variability leads to linear systems of equations for elementary sensitivities that are readily solved in conjunction with the original equation. These elementary sensitivities can be easily transformed into approximations of functional sensitivities and into sensitivities of boundary fluxes. A numerical implementation of this technique in one space dimension yields results that are consistent with exact analytical solutions and with numerical perturbation calculations. The effects of a given heterogeneity can be modeled adequately provided that the maximum relative change of the scale factor from one grid point to the next not exceed a number on the order of unity. (Author's abstract)
W90-07670

STOCHASTIC DIFFERENTIAL EQUATION MODELS OF ERRATIC INFILTRATION.

Kentucky Univ., Lexington. Dept. of Civil Engineering.
S. E. Serrano.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 703-711, April 1990. 10 fig, 27 ref.

Descriptors: *Infiltration, *Model studies, *Porous media, *Soil water, Boltzmann differential equation, Comparison studies, Computer models, Data processing, Flow characteristics.

Laboratory and field infiltration data exhibit a degree of erratic variability usually associated with measurement errors and uncertainties in the phenomenon of unsaturated porous media flow. Traditionally, these uncertainties are ignored and averaged soil characteristic curves are used in the inverse and direct modeling problems. However, it is desirable to develop models capable of reproducing the inherent variability of soil moisture in order to study the physics of flow at the laboratory level and to reproduce infiltration data in natural watersheds. Two exploratory models were tested as to their ability to replicate the erratic variability of experimental horizontal infiltration data. The first is based on the full partial differential equation of infiltration, and the second on the Boltzmann-reduced differential equation. Both models are subject to a space or a time and space random soil-water diffusivity defined as uncertainty term. Both satisfactorily reproduced the statistical properties of the experimental data. While the first model easily relates to real space and time variables, the second required less computer time. As an application of the methodology, a third model was introduced as a new approach to predict vertical infiltration in hysteretic soils in natural watersheds. For this purpose, the effect of time variability of point rainfall was represented as a shot noise process. The hysteretic loops resulting from the natural wetting and drying cycles generate a correlated random soil-water diffusivity process. (Author's abstract)
W90-07678

ESTIMATING STEADY INFILTRATION RATE TIMES FOR INFILTROMETERS AND PERMEAMETERS.

Guelph Univ. (Ontario). Dept. of Land Resource Science.
D. E. Elrick, W. D. Reynolds, H. R. Geering, and K.-A. Tan.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 759-769, April 1990. 3 fig, 4 tab, 36 ref.

Descriptors: *Hydraulic conductivity, *Infiltration, *Soil water, *Steady flow, Flow models, Infiltrometers, Permeameters, Soil properties.

In the in situ determination of hydraulic conductivity most procedures are based on a close attainment of steady state infiltration. The accuracy of the measurement is therefore dependent on both the degree to which steady state flow is attained and the validity of the assumptions in the analysis procedure. Several approximate analytical solutions of one-dimensional and three-dimensional flow provide reasonable estimates of both transient and steady state infiltration compared to the corresponding numerical solutions. Three-dimensional infiltration initially approaches steady state flow much faster than one-dimensional infiltration, but at some point close to steady flow and dependent on soil properties, one-dimensional infiltration approaches steady state faster. For both flow geometries, however, the degree of error induced in the saturated hydraulic conductivity (Ks) due to overestimating the steady state intake rate is small relative to the errors induced by capillarity, soil heterogeneity, smearing, remolding, siltation, and air entrapment. The various sources of error and variability in infiltrometer and permeameter measurements suggest that Ks can be determined within only a factor of 2 in sands, a factor of about 2-3 in loams, and perhaps to within only a factor of 3-5 in structured clays. Although these factors may seem rather large, they are probably of little consequence when compared to the tremendous variability in Ks often encountered in the field. (Author's abstract)
W90-07683

REDUCTIONIST PHYSICAL APPROACH TO UNSATURATED AQUIFER RECHARGE FROM A CIRCULAR SPREADING BASIN.

Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-07684

CHEMICAL EFFECTS OF SALINE IRRIGATION WATER ON A SAN JOAQUIN VALLEY SOIL: I. COLUMN STUDIES.

California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 3C.
W90-07698

CHEMICAL EFFECTS OF SALINE IRRIGATION WATER ON A SAN JOAQUIN VALLEY SOIL: II. FIELD SAMPLES.

California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 3C.
W90-07699

NUTRIENT CYCLING IN FORESTS OF WALKER BRANCH WATERSHED, TENNESSEE: ROLES OF UPTAKE AND LEACHING IN CAUSING SOIL CHANGES.

Oak Ridge National Lab., TN. Environmental Sciences Div.
D. W. Johnson, and D. E. Todd.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 97-104, 1990. 3 fig, 3 tab, 29 ref. Office of Health and Environmental Research, U.S. DOE Contract DE-AC05-840R21400.

Descriptors: *Cycling nutrients, *Forest watersheds, *Leaching, *Litter, *Nutrient removal, *Soil analysis, *Tennessee, *Weathering, Calcium, Hardwood, Magnesium, Trees.

Previous studies showed that subsoil exchangeable calcium ($Ca(++)$) and magnesium ($Mg(++)$) decreased over the period 1971 to 1982 in several plots on Walker Branch Watershed (Tennessee). It was hypothesized that wood accumulation (e.g., uptake and sequestering in both living and dead tree biomass) was the dominant cause of the exchangeable $Ca(++)$ decreases, whereas atmospheric deposition-induced leaching was the dominant cause of the exchangeable $Mg(++)$ decreases. As hypothesized, wood accumulation far exceeded leaching of $Ca(++)$ in those plots where soil exchangeable $Ca(++)$ decreased. The hypothesis regarding causes of exchangeable $Mg(++)$ decrease was neither accepted nor rejected from the data on hand. Leaching exceeded wood accumulation of $Mg(++)$ in three of the four plots studied (pine, Pinus; yellow-poplar, Liriodendron tulipifera; and chestnut oak, Quercus prinus). Cation leaching in these three plots was balanced by $SO4(--)$, and input-output balances indicated that soil solution $SO4(--)$ originated primarily from atmospheric deposition. Thus, the trends toward decreased subsoil exchangeable $Mg(++)$ in those particular plots (while not all statistically significant at the 95% level), are attributable primarily to atmospheric S deposition. However, leaching was minimal in the fourth plot (oak hickory, Quercus-Carya spp.) due to very low soil solution $SO4(--)$ concentrations, yet subsoil $Mg(++)$ decreases were significant at the 95% level. In the latter case, wood uptake was the dominant mechanism of $Mg(-)$ removal from soil. Although leaching and uptake can affect soil nutrient pools over periods of decades, slope position is likely the most important overall factor determining the nutrient status of these plots. colluvial activity, downslope litter transport, and lateral water flow cause organic matter and nutrient enrichment of lower slope sites and depletion of upper slope sites over the very long term. (Author's abstract)
W90-07702

FIELD TEST OF A WATER BALANCE MODEL OF CRACKING CLAY SOILS.

Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
N. J. Jarvis, and P. B. Leeds-Harrison.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/4, p 203-218, January 1990. 5 fig, 2 tab, 27 ref.

Descriptors: *Field tests, *Model studies, *Soil types, *Soil water, England, Root zone, Soil-water-plant relationships, Water storage, Water uptake.

A field test of a water balance model of cracking clay soils was developed. An important feature of the model is the dynamic treatment of both soil structure (which varies as a function of soil water content) and the crack water balance which is solved as a dynamic equilibrium between input at the soil surface, storage in cracks and uptake into aggregates. Model predictions were compared with measurements of soil water content made by neutron probe for two access tube groups located about 40 m apart in heavy clay soil (50% clay content) in southern England in two years with contrasting weather (one dry, one wet). The results clearly demonstrated the importance of bypassing flow, with soil water recharge following dry periods occurring nearly simultaneously at all depths in the profile. Root water uptake was also affected by soil structure. For example, very low values of the critical soil air content were inferred (0.5%) and this was thought to reflect preferential root growth in the well-aerated structural porosity. Model predictions and measurements were generally in excellent agreement, although there was an apparent tendency to overestimate the amount of water stored in the surface layers (0.1-0.2 m depth), particularly during autumn soil water recharge periods. This may have been due to simplifications and assumptions in the model, in particular those related to the treatment of rainfall pattern and interception loss, and also the neglect of soil water redistribution in the matrix. (Author's abstract)
W90-07722

HYDROLOGIC RESPONSES OF COMPACTED FOREST SOILS.

Southern Illinois Univ. at Carbondale. Dept. of Plant and Soil Sciences.
B. D. Gardner, and S. K. Chong.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/4, p 327-334, January 1990. 4 fig, 2 tab, 12 ref.

Descriptors: *Forest soils, *Land use, *Soil porosity, *Soil water, Bulk density, Compaction, Cores, Hydraulic conductivity, Infiltration rate, Moisture content, Runoff rates, Saturation, Sorptivity.

Soil cores were constructed in the laboratory under different antecedent moisture content and degrees of compaction. Sorptivity, effective hydraulic conductivity, and the Boltzmann constant were measured using the unsaturated sorptivity device. Subsequently, the bulk density and the degree of saturation were also determined. All measured parameters were sensitive to changes in bulk density and antecedent moisture content. However, the effect of water unfillable porosity present as entrapped air caused the values of measured hydrologic properties to deviate from theory. Sorptivity is also sensitive to the effect of entrapped air which can radically influence infiltration rates and effective hydraulic conductivity. These findings tend to reinforce the usefulness of sorptivity for the study of soil water movement and the runoff potential of certain land uses, e.g. forest harvesting and agriculture. (Author's abstract)
W90-07729

CHARACTERIZATION OF A SANDY AQUIFER MATERIAL AT THE GRAIN SCALE.
Stanford Univ., CA. Dept. of Civil Engineering.
W. P. Ball, C. Buehler, T. C. Harmon, D. M. MacKay, and P. V. Roberts.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 3, p 253-295, March 1990. 7 fig, 10 tab, 76 ref. EPA Exploratory Research Grant Program Contract No. R-813344.

Descriptors: *Aquifers, *Path of pollutants, *Soil porosity, *Solute transport, *Sorption, Gas adsorption, Mercury porosimetry, Model studies, Particle size, Sand.

Solute sorption in aquifer systems is significantly affected by processes which occur at the scale of individual solid particles, such that proper physical characterization of the solids is requisite to fully understanding solute transport. Because intraparticle porosity, specific surface area, and organic carbon are quite low for sandy materials, methods routinely used for characterizing solids must be carefully evaluated and adapted for use on aquifer solids. These methods were applied to aquifer material acquired at a site in Borden, Ontario, where numerous transport studies have been conducted. Results with well-characterized model solids are also included, as appropriate, for method evaluation. Pulverization of samples in a shatterbox was shown to be useful for homogenizing samples and reducing variability. Surface area measurements were indicative of significant internal porosity, and pore size distributions obtained by gas adsorption and mercury porosimetry were found to be consistent and complementary. For the Borden material--which has an immeasurably low clay mineral content--specific surface area, intraparticle porosity, and organic carbon content were all greatest in the larger size fractions. (Author's abstract)
W90-07905

UNSTEADY RADIAL FLOW OF GAS IN THE VADOSE ZONE.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 5B.
W90-07906

PRINCIPLES OF EVALUATION OF SOIL WATER RESIDENCE TIME USING QUEUEING DISCIPLINES WITH WATER BUDGET DATA (THEORETICAL BACKGROUND-I).
Kent State Univ., OH. Dept. of Geology.
R. F. Gamble, Y. Eckstein, and W. M. Edwards.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 1-25, February 1990. 13 fig, 4 tab, 6 ref.

Descriptors: *Hydrologic models, *Soil chemistry, *Soil water, Fluid elements, Lysimeters, Residence time, Water budget.

Soil water residence time is an important aspect of soil hydrology. It is an important factor affecting the chemical composition of water in the soil. Water that makes up recharge and discharge to and from a hydrologic reservoir can be considered to consist of individual increments of water called fluid elements. Queueing disciplines can be used to describe the order in which the fluid elements move through the reservoir. Possible queueing disciplines that can be related to soil water movement are last-in-first-out (LIFO), first-in-first-out (FIFO), and combination of LIFO and FIFO. When water budget records are available, the queueing disciplines can be used as models to allow the calculation of residence time estimates. Computer algorithms have been written for the purpose of making estimates of soil water residence times in a weighable monolith lysimeter. The residence time values provided by such models can only be considered to be approximations of the actual soil water residence times. The models give information on the order of magnitude and variability of residence times of water in the soil reservoir. (See also W90-07976) (Author's abstract)
W90-07975

EVALUATION OF SOIL WATER RESIDENCE TIME IN A MONOLITH LYSIMETER FROM THE APPLICATION OF QUEUEING DISCIPLINES TO WATER BUDGET DATA (DEMONSTRATION-II).
Kent State Univ., OH. Dept. of Geology.
R. F. Gamble, Y. Eckstein, and W. M. Edwards.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 27-49, February 1990. 11 fig, 10 tab, 7 ref.

Descriptors: *Hydrologic budget, *Lysimeters, *Model studies, *Soil water, Evapotranspiration, Percolation, Precipitation, Residence time, Runoff.

Soil water residence time in a monolith lysimeter at the North Appalachian Experimental Watershed was estimated by applying queueing disciplines to the lysimeter water budget data. The lysimeter contains an undisturbed soil block measuring approximately 6 ft wide, 14 ft long and 8 ft deep, and a permanent grass cover is maintained on the soil. The lysimeter water budget data used consist of monthly totals of precipitation, evapotranspiration, runoff and percolation for the period of January, 1947–December, 1985. The three following queueing discipline models were applied to the water budget data: (1) all of the water in the lysimeter follows first-in-first-out (FIFO) queueing discipline; (2) all of the water in the lysimeter follows last-in-first-out (LIFO) queueing discipline; and (3) discharge by evaportranspiration follows LIFO queueing discipline and discharge by percolation follows FIFO queueing discipline. The FIFO model generated minimum residence times of three months and maximum residence times of eleven months with approximately half the assigned values being six months or less. The LIFO model generated minimum residence times of less than one month and a maximum of 140 months. More than half of the values were less than one month. The combined LIFO-FIFO model generated minimum residence time of less than one month and a maximum residence time of 68 months with half of the values being less than six months. The FIFO model tended to assign the higher residence time values to water that entered the lysimeter in the summer months, while the LIFO and LIFO-FIFO models tended to assign the high-residence time values to water that entered the soil in the winter months. (See also W90-07975) (Author's abstract)
W90-07976

DERIVED PDF FOR THE INITIAL SOIL MOISTURE IN A CATCHMENT.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
J. B. Valdes, M. Diaz-Granados, and R. L. Bras.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 163-176, February 1990. 3 fig, 2 tab, 18 ref.

Descriptors: *Infiltration, *Soil water, Exfiltration, Probability distribution, Storms.

The probability distribution of the initial soil moisture concentration of a catchment was derived based on the one-dimensional infiltration-exfiltration process of a layer of soil. Analytical expressions were found for the initial and final soil moisture concentration during a storm event. These analytical expressions were then used in simulation experiments for different combinations beginning of a storm and its variance. A beta PDF was then fitted to completely characterize its probability distribution. Finally, a general expression for both the mean and the variance of the initial soil moisture is given only on climate and soil characteristics. (Author's abstract)
W90-07984

STABILITY OF SOIL AGGREGATES IN RELATION TO ORGANIC CONSTITUENTS AND SOIL WATER CONTENT.
Canterbury Agriculture and Science Centre (New Zealand).
R. J. Haynes, and R. S. Swift.
Journal of Soil Science JSSCAH, Vol. 41, No. 1, p 73-83, March 1990. 3 tab, 24 ref.

Descriptors: *Soil aggregates, *Soil organic matter, *Soil stability, *Soil water, Carbohydrates, Cultivated lands, Pastures, Soil chemistry.

The effects of soil organic matter content, soil water content and duration of wet-sieving on aggregate stability of soils with contrasting cropping histories were investigated. Long-term pasture samples had a greater aggregate stability than long-term arable samples. However, air-drying aggregates before wet-sieving increased the aggregate stability of long-term pasture samples, but decreased that of long-term arable samples. With increasing duration of wet-sieving, the proportion of water-stable aggregates declined until a near-constant value was reached for each sample. Thus, within a sample there are aggregates possessing a wide range of stabilities; with increasing time under arable cropping there is an increase in the proportion of unstable aggregates present, and the measured aggregate stability, therefore, declines. Unstable aggregates (defined as those dispersed after wet-sieving for 1 min) generally had lower organic matter content than stable ones (those still intact after sieving for 15 min). The aggregate stability of a regrassed site (13 years of arable plus 2 years of pasture) was markedly higher than that of a corresponding site from 15 years of arable cropping. Nonetheless, levels of organic matter (organic C, total N and hydrolysable carbohydrate) were almost identical at the two sites. However, aggregates from the regrassed site did have a higher biomass C and water-extractable carbohydrate content than those from the 15-year arable site. For a group of soils with varying cropping histories, aggregate stability was significantly more closely correlated with hot water-extractable carbohydrate content than with organic C or hydrolysable carbohydrate content. It is suggested that the hot water-extractable carbohydrate fraction may represent a pool of carbohydrate involved in the formation of stable aggregates. (Author's abstract)
W90-07996

DIRECTIONAL STRENGTH IN AGGREGATES AS AFFECTED BY AGGREGATE VOLUME AND BY A WET/DRY CYCLE.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
A. Hadas.
Journal of Soil Science JSSCAH, Vol. 41, No. 1, p 85-93, March 1990. 1 fig, 5 tab, 17 ref. United States-Israel Binational Agricultural Research and Development Fund Grant No. I-812-84 and US-1320-87.

Descriptors: *Soil aggregates, *Soil moisture deficiency, *Soil strength, *Soil water, Clays, Density, Loam, Tensile strength.

Reduction of aggregate size in the upper, tilled soil layer as a result of one wet/dry cycle was observed for sandy soil and clay soils. Bulk density of aggregates tends to increase as their size diminishes for the clay after the wet/dry cycle, while similar

changes in bulk density for loam were observed only for aggregates smaller than 5.6 cm. Slaking and water-drop impact seem to be the major factors in reducing the aggregate size of the sandy loam. Swelling and shrinking affect clay aggregates of all size groups, but only aggregates smaller than 4.0 mm for sandy loam. The tensile strength of sandy loam aggregates appears related to the axis along which the stresses are applied. A definite directional dependence of tensile strength was observed, e.g. the shorter the axis, the larger the tensile strength. The directional strength dependence was apparently not affected by one wet/dry cycle. (Author's abstract)
W90-07997

POWER-FUNCTION MODEL FOR THE SOIL MOISTURE CHARACTERISTIC.
Lincoln Coll., Canterbury (New Zealand). Dept. of Soil Science.
G. D. Buchan, and K. S. Grewal.
Journal of Soil Science JSSCAH, Vol. 41, No. 1, p 111-117, March 1990. 3 fig, 1 tab, 9 ref.

Descriptors: *Mathematical models, *Soil saturation, *Soil water, *Soil water suction, Data collections, Mathematical analysis, Mathematical equations, Model testing.

The minimum number of parameters required to model the unsaturated soil moisture characteristic, relating volumetric water content (theta) and matric suction (psi), is shown to be two. A third parameter, theta = theta sub s at saturation, is required to define its saturation limit. The popular power-function psi/psi sub e = (theta/theta sub s) to the power of b is the most general three-parameter model, with psi normalized by a notional air-entry potential, psi sub e. When log-transformed, e.g. as ln psi = a + bln(theta/theta sub s), it gives a good fit to observations over varying ranges of psi. Using US, Australian, UK and New Zealand data, the authors show that a, b and theta sub s in this formulation are uncorrelated across a wide range of textures, providing a 'basis set' of independent parameters. An alternative formulation was previously used, where ln psi = a" + bln(100theta), with theta rescaled to a percentage. The reported correlation between a" and b, which led to the 'one-parameter model' of the characteristic, is shown to be a mathematical artifact, arising from absorption of the term—b(ln(100) + ln psi sub s) into a". (Author's abstract)
W90-07998

LABORATORY STUDY OF THE DISPERSION SCALE EFFECT IN COLUMN OUTFLOW EXPERIMENTS.
University of Agriculture, Faisalabad (Pakistan).
For primary bibliographic entry see Field 5B.
W90-08202

APPROXIMATE CALCULATION OF ADVECTIVE GAS-PHASE TRANSPORT OF 14C AT YUCCA MOUNTAIN, NEVADA.
Lawrence Livermore National Lab., CA. Earth Sciences Dept.
R. B. Knapp.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 2, p 133-154, January 1990. 13 fig, 1 tab, 25 ref.

Descriptors: *Advection, *Hazardous waste disposal, *Nevada, *Path of pollutants, *Radioactive waste disposal, *Soil gases, *Yucca Mountain, Carbon radioisotopes, Differential equations, Diffusion, Dispersion, Isotope studies, Kinematic wave theory, Kinematic waves, Mathematical analysis, Radioactive half-life, Waste characteristics, Water transport.

It has been proposed to place high-level nuclear waste in the unsaturated zone at Yucca Mountain, Nevada. The presence of such waste will cause local heating, convective fluid circulation, and has the potential to cause release and transport of chemicals. A quasilinear partial differential equation, which describes gas-phase transport of a 14C kinematic wave through a porous medium, may be applied to one possible release scenario at the

proposed Yucca Mountain, Nevada, high-level radioactive waste repository. Advection, isotope exchange between CO2 in a flowing gas phase and HCO3(-) in a static aqueous phase, and radioactive decay are incorporated. The mass fraction of 14C in the gas phase is controlled by radioactive decay. The greater the partitioning of carbon into the liquid phase, the greater the retardation of the 14C wave velocity and the greater the ultimate reduction in the mass fraction of 14C in the gas phase from initial conditions. Partitioning is greatest at low temperatures and high pH values. The governing equation has been applied using conditions that may possibly occur at the proposed Yucca Mountain repository. Calculations indicate that the 14C wave takes about 5900 years to reach the surface with a mass fraction of 14C in the gas phase equal to 25 ppm. Diffusion and dispersion are not of major importance for these conditions. These calculations are approximate due to the number of assumptions involved. Discharge of 14C into the gas phase before the selected time would accelerate wave arrival and increase the amount of 14C reaching the surface. (Author's abstract)
W90-08203

DISTRIBUTION OF DEUTERIUM AND OXYGEN-18 DURING UNSTEADY EVAPORATION FROM A DRY SOIL.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
For primary bibliographic entry see Field 2D.
W90-08217

TEMPERATURE GRADIENT EFFECTS ON STABLE ISOTOPE AND CHLORIDE PROFILES IN DRY SOILS.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources.
C. J. Barnes, G. B. Allison, and M. W. Hughes.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 69-87, December 1989. 8 fig, 1 tab, 17 ref.

Descriptors: *Chlorides, *Evaporation, *Soil chemistry, *Soil water, *Stable isotopes, *Temperature effects, *Temperature gradient, *Tracers, Deuterium, Error analysis, Evaporation rate, Experimental data, Groundwater movement, Isotherms, Isotope studies, Model studies, Oxygen isotopes, Soil moisture deficiency, Solute transport, Theoretical analysis, Water transport.

Experimental profiles of oxygen-18 and deuterium observed after evaporation from soil were compared with theoretical ones. The theoretical profiles are based on a simplified version of previously presented theory for nonisothermal movement of the stable isotopes of water. Under these experimental conditions, the analytical model yields an excellent fit to the data, and allows predictions of the effects of a temperature gradient to be made. The theory shows that errors of 100% or more in estimates of evaporation rate may result if the temperature distribution in the soil is ignored. A second set of experimental profiles obtained from sealed, nonisothermal tubes was performed. Results from these experiments give insights into the relative importance of liquid and vapor transport, and differences that might be expected between isotopes and nonvolatile solutes (e.g; chlorine) used as tracers for determining water movement. It was found that although the water content and stable isotope profiles rapidly attained steady state, chloride profiles were far from equilibrium after nearly a year. This implies that field profiles involving nonvolatile solutes evolve at vastly different rates to those involving the naturally occurring isotopes of water. (Author's abstract)
W90-08218

MECHANISMS OF WATER STORAGE IN SALT MARSH SEDIMENTS: THE IMPORTANCE OF DILATION.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
W. K. Nuttle, H. F. Hemond, and K. D. Stolzenbach.
Hydrological Processes HYPRE3, Vol. 4, No. 1, p

1-13, January/March 1990. 6 fig, 30 ref. National Science Foundation grant BSR 8306433, and Sea Grant NA84AA-D-00046.

Descriptors: *Marine sediments, *Salt marshes, *Soil aeration, *Soil water, *Water storage, *Wetlands, Coastal marshes, Evapotranspiration, Infiltration, Marsh plants, Massachusetts, Nutrient transport, Plant physiology, Sediments, Soil shrinking, Soil swelling.

Water storage in salt marsh sediments has become an important factor in studies of nutrient dynamics and plant physiology. Direct observation of surface displacement in two New England salt marshes shows that shrinking and swelling of the sediment is an important mechanism for water storage. This mechanism accounts for 20 percent of the total change in water content of the sediment in Belle Isle Marsh, Massachusetts, and for as much as 36 percent and 86 percent of the total at separate sites in Sippewissett Marsh, Massachusetts. Swelling in response to infiltration appears to follow the Hemond infiltration model. Shrinkage decreases the aeration of the sediment compared to soils that do not shrink, and reduced aeration represents a physiological stress to vegetation. For a given depth of water loss, e.g. one day's evapotranspiration, more shrinkage, less aeration, and higher stresses on vegetation will occur in deeper sediment deposits. (Author's abstract)
W90-08324

TRIALS OF AN ACOUSTIC METHOD OF MEASURING PIEZOMETRIC LEVELS IN STANDPIPES.
Transport and Road Research Lab., Crowthorne (England). Overseas Unit.
For primary bibliographic entry see Field 7B.
W90-08326

SIMULATION OF CHEMICAL TRANSPORT IN UNSATURATED SOIL.
Bechtel Environmental, Inc., Oak Ridge, TN.
For primary bibliographic entry see Field 5B.
W90-08340

IMPORTANCE OF CLIMATOLOGICAL VARIABILITY AND THE RATE AT WHICH WASTE IS ADDED TO MODELING WATER BUDGET OF LANDFILLS.
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 5E.
W90-08562

SENSITIVITY OF EVAPOTRANSPIRATION AND SOIL MOISTURE TO POSSIBLE CLIMATIC CHANGES.
Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 2D.
W90-08582

SOIL MOISTURE DYNAMICS IN SOUTH-CENTRAL SWEDEN IN A 100 YEAR PERSPECTIVE.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
L. Andersson.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 252-261, 5 fig, 13 ref.

Descriptors: *Model studies, *Soil water, *Sweden, 100-year perspective, Anthropogenic effects, Discharge area, Fluctuations, Geographic information systems, Moisture deficits, Recharge basins.

Interannual fluctuations of soil moisture deficits in south-central Sweden were analyzed in a 100 year perspective with the help of a dynamic water partitioning model. Considerable fluctuations of 10, 30, and 50-year mean deficits, a general secular trend towards higher summer deficits and larger

fluctuations around the median were revealed. In light of the critical importance of the choice of time period, the concepts of return and standard periods were challenged. A Geographical Information System (GIS) was used to detect alterations of the spatial distribution of areas with different probability to act as recharge or discharge areas. Wetness impacting human interventions were shown to, on average, have caused a slight desiccation of the landscape although the impacts locally could be large. (See also W90-08565) (Author's abstract) W90-08583

MONITORING OF VEGETATION PERIOD COURSE OF SOIL MOISTURE BASED ON MEASUREMENTS AND EVALUATION IN HUNGARY.
Kozponti Meteorologiai Intezet, Budapest (Hungary).
Z. Dunkel.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 262-271, 4 fig, 4 ref.

Descriptors: *Hungary, *Soil water, *Soil-water-plant relationships, *Transpiration, Agriculture, Drought, Gravimetric methods, Hydrologic data.

Four years ago a network was established for monitoring the soil moisture. The annual variability of the soil moisture was measured using gravimetric and neutron sonde. For calculation of the soil moisture expressed in precipitation units a simple method using soil moisture and transpiration values measured at the Agrometeorological Observatory of Szarvas in the southeast part of Hungary was used. The measurements were made under typical plain circumstances in the main agricultural area of the country. It was found that during the vegetation period the water content decreases to the wilting point in almost every year. The soil moisture content provides useful information for agricultural purposes in a country like Hungary where droughts are frequently recorded. (See also W90-08565) (Author's abstract) W90-08584

ESTIMATION OF AVAILABLE WATER-HOLDING CAPACITY OF SOILS IN EUROPE.
International Soil Reference and Information Centre, Wageningen (Netherlands).
H. Groenendijk.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 293-299, 1 fig, 1 tab, 11 ref.

Descriptors: *Europe, *Soil moisture retention, *Soil types, *Soil water, Agriculture, Climates, Crop rooting depth, Mapping, Rhizosphere, Soil texture.

As a contribution to an agro-climate study, a simple method was set up to estimate the available water-holding capacity (AWC) of soils in Europe. Soil data taken from maps were stored in of a 1/2 x 1/2 degree grid. For each gridcell three dominant soil types were recorded, with information on topsoil texture, stoniness and slope. The data set covers the European territory up to the 44th degree of longitude. The method suggested for estimating AWC is based on texture-available reserve relations, given in the literature. The crop rooting depth determines the thickness of the soil layer contributing to the AWC. The rooting depth can be derived from the soil type, and a reduction factor is proposed for stony soils. (See also W90-08565) (Author's abstract) W90-08587

2H. Lakes

ERIE AND CAMPBELL LAKES. FINAL REPORT: RESTORATION IMPLEMENTATION AND EVALUATION.
Entranco Engineers, Inc., Kirkland, WA.
For primary bibliographic entry see Field 5G.
W90-07508

HYDE PARK LAKE RESTORATION PROJECT, NIAGARA FALLS, NEW YORK.
New York State Dept. of Environmental Conservation, Albany.
For primary bibliographic entry see Field 5G.
W90-07509

DEVELOPMENT OF CRITICAL LIFE STAGE ASSAYS: TERATOGENIC EFFECTS OF ASH BASIN EFFLUENT COMPONENTS ON FRESHWATER FISH, GAMBUSIA AFFINIS AND DAPHNIA.
Voorhees Coll., Denmark, SC.
For primary bibliographic entry see Field 5C.
W90-07511

GORTON POND, WARWICK, RHODE ISLAND, LAKE RESTORATION PROJECT. PHASE I: DIAGNOSTIC/FEASIBILITY STUDY.
Keyes Associates, Providence, RI.
For primary bibliographic entry see Field 5G.
W90-07512

LAKE RONKONKOMA CLEAN LAKES STUDY.
Suffolk County Dept. of Health Services, Hauppauge, NY.
For primary bibliographic entry see Field 5G.
W90-07515

LAKE SACAJAWEA RESTORATION PROJECT, CITY OF LONGVIEW, WASHINGTON.
Gibbs and Olson, Inc., Longview, WA.
For primary bibliographic entry see Field 5G.
W90-07516

DELAVAN LAKE: A RECOVERY AND MANAGEMENT STUDY. WATER RESOURCES MANAGEMENT WORKSHOP.
Wisconsin Univ.-Madison. Inst. for Environmental Studies.
For primary bibliographic entry see Field 5G.
W90-07517

RIVER ECOSYSTEMS: ECOLOGICAL CONCEPTS AND DYNAMICS.
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 3-19, 12 fig, 2 tab, 57 ref.

Descriptors: *Ecosystems, *Rivers, Cycling nutrients, Denitrification, Detritus, Drainage area, Flood plains, Fluvial sediments, Geochemistry, Nutrients, Organic matter, River flow, Stream biota, Surface-groundwater relations.

For larger rivers, the primary characteristic to consider for understanding ecosystem dynamics is the variety of interactions between the channel and the floodplain. The importance of these interactions has long been recognized. A simple diagram shows that they act in three spatial dimensions: longitudinal, vertical, and cross-sectional. A fourth dimension, time, also has an effect, during flooding, for example. To consider the processes that govern the dynamics of flowing-water ecosystems, three hierarchical levels are considered: (1) the microhabitat scale allows a consideration of microbial processing and nutrient dynamics; (2) the stream scale relates to the river continuum concept; and (3) the landscape scale is needed to consider the dynamics of the fluvial corridor, the floodplain as a whole. In temperate climates, the development begins in the autumn, at the time when the fallen leaves from the riverside vegetation accumulate in the watercourses. In the case of a relatively conservative element, phosphorus, originating on the catchment, the length of a spiral can be defined. The length represents the average distance covered on its way downstream by a nutrient atom during a cycle. A rapid recycling,

resulting from high biological activity associated with a slowing of the downstream movement, results in a shortening of the spiral loops. Interactions between the river channel and the floodplain area occur via the filtering action of the riparian woods. The riverine forests, a remainder of the original alluvial forest, form a safety barrier between the groundwater and surface waters. The disappearance of nitrates from the groundwater during its passage through the shoreline forest leads to a major reduction in concentrations between the aquifer of the agricultural areas and the river water. This reduction is the result of a microbial denitrification of which the rates measured--up to 50 mg N2/sq m/d--are much higher than those obtained in other natural ecosystems. (See also W90-07522) (Lantz-PTT) W90-07523

SPECIAL FEATURES OF LAKE ECOSYSTEMS.
Toulouse-3 Univ. (France). Lab. d'Hydrobiologie.
J. Capblancq.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 21-34, 4 fig, 26 ref.

Descriptors: *Ecosystems, *Lakes, *Limnology, *Path of pollutants, Algae, Biodegradation, Biomass, Carbon cycle, Cycling nutrients, Nitrogen, Nutrients, Organic matter, Phosphorus, Photosynthesis.

Lakes have long been considered as prototypes of ecosystems, i.e., more or less closed units, well defined physically, and characterized by a certain functional autonomy. As for any ecosystem, overall function is based on the dependence and interdependence of the various communities of living organisms and their interactions with the abiotic environment. The overall functional metabolism can be divided into two main parts: (1) photosynthesis production of organic material by autotrophic organisms; and (2) consumption and degradation (respiration) of this organic material by heterotrophs (animals, microbes) with the concomitant recycling (mineralization) of nutrients. Lakes are open systems continuously supplied with inorganic and organic matter, either dissolved or suspended in the water flowing in from the water basin. There is also continuous exchange with the atmosphere (gas and heat) and with sediments. A lake is intimately coupled with its watershed; it can be considered as a part of the catchment ecosystem where it operates as a retention zone for components transported from the land due to the greatly reduced transportation power of the water. The circulation of elements carried from the water basin is controlled not only by physical processes depending on turbulence (eddy diffusion, sedimentation, resuspension, or advection), but also by biological activity. Exchanges of matter between water, organisms, and sediments are intimately linked to the carbon cycle which impinges directly and indirectly on the cycles of numerous other elements. The major part of the carbon in a lake comes from a combination of the input from the water basin and the autochthonous primary production. The input is essentially made up of residues of terrestrial vegetation carried in from the water basin. These more or less degraded materials are relatively refractory, and they participate both directly in biological processes and indirectly, by reducing light penetration as well as by their ability to form complexes with many ions. The biomass of phytoplankton produced in a lake depends on the amounts of nutrients available. It has been found that: (1) the rate of diffusion of atmospheric CO_2 is sufficient to sustain the C requirements of increased phytoplankton biomass in phosphate-enriched experimental lakes; (2) a low N/P ratio favors the development of N-fixing, filamentous blue-green algae; and (3) the exhaustion of silica due to a large growth of diatoms leads to their replacement by nonsilica-containing algae. (See also W90-07522) (Lantz-PTT) W90-07524

FACTORS AFFECTING SOURCES AND FATE OF PERSISTENT TOXIC ORGANIC CHEMI-

Group 2H—Lakes

CALS: EXAMPLES FROM THE LAURENTIAN GREAT LAKES.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 5B.
W90-07533

HANDBOOK OF LIMNOLOGY.
Freiburg Univ. (Germany, F.R.).
J. Schwoerbel.
John Wiley and Sons, New York, New York. 1987. 228p. Translated by B. Hemmings.

Descriptors: *Handbooks, *Lake restoration, *Limnology, Flow profiles, Lakes, Light penetration, Organic compounds, Physicochemical properties, Primary productivity, Seasonal variation, Streamflow, Streams, Wastewater treatment, Water pollution control, Water pollution effects.

This textbook of limnology covers both theoretical and applied knowledge. Much of the newer material is concerned with the limnology of flowing streams, the process of primary production, sewage treatment, and lake restoration measures. The coverage also includes a description of the physicochemical properties of water, the effects of seasonal changes, and the effect of light stratification and flow upon the distribution of species and biochemical activities. The effects of organic pollution on inland waters and methods for water pollution control. (Lantz-PTT)
W90-07550

INFLUENCE OF LAKE RESTORATION MEASURES ON WATER QUALITY AND WATER QUANTITY IN BLUE LAKE, IOWA. OXBOW LAKE STUDY: PHASE III.
Iowa State Water Resources Research Inst., Ames.
For primary bibliographic entry see Field 5G.
W90-07556

WAPATO LAKE RESTORATION: A DISCUSSION OF DESIGN CONSIDERATIONS, CONSTRUCTION TECHNIQUES AND PERFORMANCE MONITORING.
Entranco Engineers, Inc., Kirkland, WA.
For primary bibliographic entry see Field 5G.
W90-07559

RESTORATION OF THE POND IN CENTRAL PARK, MANHATTAN, NEW YORK CITY.
New York City Dept. of Parks and Recreation. Capital Projects Div.
For primary bibliographic entry see Field 5G.
W90-07563

CHLORINE-36 TRACING OF SALINITY SOURCES IN THE DRY VALLEYS OF VICTORIA LAND, ANTARCTICA.
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
For primary bibliographic entry see Field 2K.
W90-07569

EFFECTS OF MULTIPLE DISTURBANCE ON MACROINVERTEBRATE COMMUNITIES IN THE ACHERON RIVER, VICTORIA.
Monash Univ., Clayton (Australia). Centre for Stream Ecology.
For primary bibliographic entry see Field 2E.
W90-07648

APPLICATION OF A GUARANTEED REGRESSION MODEL TO TROPHIC INTERACTION IN AN AQUATIC SYSTEM.
South Bohemian Biological Centre, Ceske Budejovice (Czechoslovakia).
For primary bibliographic entry see Field 7C.
W90-07651

BIOCHEMICAL OXYGEN DEMAND AND ALGAE: FRACTIONATION OF PHYTOPLANKTON AND NONPHYTOPLANKTON RESPIRATION IN A LARGE RIVER.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
R. R. H. Cohen.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 671-678, April 1990. 7 fig, 3 tab, 45 ref.

Descriptors: *Algae, *Biochemical oxygen demand, *Chlorophyll a, *Dissolved oxygen, *Eutrophication, *Primary productivity, Data interpretation, Mass balance equations, Phytoplankton, Respiration, River ecology.

Mass balance equations for dissolved oxygen in streams are formulated to account for, among other variables, algal respiration (R), and biochemical oxygen demand (BOD). The oxygen consumption measured in primary productivity-respiration analyses is not R but is total community oxygen consumption (TCOC), and BOD measurements are complicated by undefined algal components. Ultimate BOD was found to be 0.24 mg of oxygen consumed per microgram chlorophyll a and carbonaceous BOD was 0.20 per microgram chlorophyll a in excess of *background BOD. The results were similar for live and dead algae. Phytoplankton respiration was fractionated from nonphytoplankton oxygen consumption (NPOC) by the regression of respiration against chlorophyll a to obtain a y intercept of zero chlorophyll. The intercepts, NPOC, closely matched oxygen consumption measured when phytoplankton biomass was very low. Phytoplankton respiration, calculated as the residual of the difference between TCOC and NPOC, ranged from 0.2 to 1.5 (mean = 0.88) mg oxygen per mg chlorophyll a per hour, close to the literature value of 1 (in cultures). Depth-integrated (DI) phytoplankton respiration was 1/4 to 1/3 of DI gross primary productivity and 1-3% of maximum primary productivity. The separation of phytoplankton R and NPOC permitted the demonstration that R probably is not a simple function of productivity. (Author's abstract)
W90-07675

EFFECTS OF HEDGING ON RESERVOIR PERFORMANCE.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W90-07679

MINERALIZATION OF SURFACTANTS BY THE MICROBIOTA OF SUBMERGED PLANT DETRITUS.
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
For primary bibliographic entry see Field 5B.
W90-07687

ENUMERATION AND BIOMASS ESTIMATION OF PLANKTONIC BACTERIA AND VIRUSES BY TRANSMISSION ELECTRON MICROSCOPY.
Bergen Univ. (Norway). Dept. of Microbiology and Plant Physiology.
For primary bibliographic entry see Field 7B.
W90-07688

DIEL NITROGEN FIXATION BY CYANOBACTERIAL SURFACE BLOOM IN SANCTUARY LAKE, PENNSYLVANIA.
State Univ. of New York Coll. at Fredonia. Environmental Resources Center.
T. A. Storch, G. W. Saunders, and M. L. Ostrofsky.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 2, p 466-471, February 1990. 5 fig, 31 ref.

Descriptors: *Algal blooms, *Cyanophyta, *Eutrophic lakes, *Limnology, *Nitrogen fixation, *Pennsylvania, Dissolved oxygen, Photosynthesis, Temporal variation.

Diel nitrogen fixation studies were conducted with assemblages of cyanobacteria sampled from surface blooms on Sanctuary Lake, PA. The studies were conducted between July and September of 1982 to 1985 by using the acetylene reduction technique.

Assemblages with the lowest cell concentrations (900,000 to 1,000,000 cells per mL) exhibited nitrogen fixation activity throughout the day, with maximum fixation rates occurring in mid to late afternoon; fixation proceeded throughout the night at rates equivalent to 23 to 28% of the afternoon maximum. In studies conducted with the highest cell concentrations (3,700,000 to 6,700,000 cells per mL), fixation rates reached maximum values in mid to late morning. The rates declined rapidly throughout the midday period and subsequently ceased from late afternoon until sunrise on the following day. The afternoon decline and cessation of fixation exhibited by high cell concentrations correlated with photosynthetically induced low total carbon dioxide (CO_2) and supersaturating oxygen (O_2) concentrations. The midday decline could be prevented and partially reversed by experimentally lowering O_2 and increasing total CO_2 concentrations. Under experimental conditions which simultaneously prevented supersaturating O_2 concentrations and maintained high total CO_2 availability, nitrogen fixation continued throughout the solar day, with maximum rates occurring at midday. These observations indicate that temporal changes in photosynthetic activity may affect diel fluctuations in nitrogen fixation. (Author's abstract)
W90-07691

BACTERIAL PRODUCTION AND GROWTH RATE ESTIMATION FROM (H3)THYMIDINE INCORPORATION FOR ATTACHED AND FREE-LIVING BACTERIA IN AQUATIC SYSTEMS.
Universidad del Pais Vasco, Bilbao (Spain). Dept. de Microbiologia e Inmunologia.
For primary bibliographic entry see Field 7B.
W90-07692

SEASONALITY OF PLANKTONIC CILIATED PROTOZOA IN 20 SUBTROPICAL FLORIDA LAKES OF VARYING TROPHIC STATE.
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
J. R. Beaver, and T. L. Crisman.
Hydrobiologia HYDRB8, Vol. 190, No. 2, p 127-135, February 1990. 5 fig, 1 tab, 36 ref.

Descriptors: *Eutrophic lakes, *Florida, *Limnology, *Oligotrophic lakes, *Protozoa, *Zooplankton, Biomass, Seasonal variation, Subtropical regions, Trophic level.

The planktonic ciliate populations of 20 Florida lakes ranging from oligotrophic to hypereutrophic were examined monthly for one year. Oligotrophic lakes displayed abundance peaks during fall mixis and biomass peaks in late winter and fall. Mesotrophic systems exhibited a spring-fall bimodality in ciliate abundance with a biomass maxima occurring during fall. Eutrophic/hypereutrophic lakes had pronounced abundance and biomass maxima during summer, with the large ciliates Plagioplya nasuta and Paramecium trichium often contributing heavily to the midsummer biomass peak. Members of the Oligotrichida numerically dominated abundance and biomass peaks in oligotrophic lakes while the Scuticociliatida dominated the communities of higher trophic states. Total ciliate abundance and biomass were strongly correlated with chlorophyll a concentrations as were various ciliate taxonomic groups. It is apparent from the data that seasonal trends of major ciliate orders are a function of trophic state for Florida lakes, and it is likely that subtropical thermal regimes and lake depth largely determine suitability of food resources. Departures from these generalized schemes usually occurred in the shallowest lakes of each subset and were coincident with destratification during the normal period of stratification. Although temperature shows a weak but significant relationship with major ciliate components, it is felt that temperature has a direct influence on ciliate seasonal dynamics only in the most productive Florida systems that are often holomictic. (Vernooy-PTT)
W90-07694

LAKE LEVEL INFLUENCES ON SEDIMENT AND NUTRIENT RETENTION IN A LAKESIDE WETLAND.

Vermont Univ., Burlington. School of Natural Resources.

J. C. Clausen, and G. D. Johnson.

Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 83-88, 1990. 7 fig, 2 tab, 27 ref.

Descriptors: *Lakes, *Limnology, *Nutrient transport, *Sediment transport, *Water level fluctuations, *Wetlands, Lake Champlain, Nitrogen, Path of pollutants, Phosphorus, Seasonal variation, Suspended solids, Vermont, Water sampling.

Lake levels, sediment and nutrient retention, and flows were studied in a 180-ha wetland adjacent to Lake Champlain, VT, to assess the role of lake levels on sediment and nutrient retention within the wetland. This wetland received both point and nonpoint sources of nutrients. Input, output, and within-wetland water samples were collected at 15 sites, and flows were measured nine times in 1983 at lake levels varying over 2 meters. The ratio of wetland inflow to outflow was related to changes in lake levels. During spring, the concentrations of total suspended solids, total P, and total Kjeldahl N throughout the wetland were lower than during summer and fall periods. Wetland outlet concentrations decreased with rising lake levels. When wetland inflows exceeded outflow, there was a net mass retention of total suspended solids, total P, and total Kjeldahl N. Exports from the wetland decreased as lake level increased. The sediment and nutrient treatment capacity of this lakeside wetland appeared to be dominated by hydrologic influences. (Author's abstract)
W90-07701

RELATIVE EFFECTS OF ENRICHMENT AND CLIMATE CHANGE ON THE LONG-TERM DYNAMICS OF DAPHNIA IN ESTHWAITE WATER, CUMBRIA.

Freshwater Biological Association, Ambleside (England). Windermere Lab.

For primary bibliographic entry see Field 5C.
W90-07713

CHANGES IN PHYTOPLANKTON OVER VARIOUS TIME SCALES IN A SHALLOW, EUTROPHIC: THE LOCH LEVEN EXPERIENCE WITH SPECIAL REFERENCE TO THE INFLUENCE OF FLUSHING RATE.

A. E. Bailey-Watts, A. Kirika, L. May, and D. H. Jones.

Freshwater Biology FWBLAB, Vol. 23, No. 1, p 85-111, February 1990. 19 fig, 74 ref.

Descriptors: *Eutrophic lakes, *Limnology, *Loch Leven, *Phytoplankton, *Scotland, *Water pollution effects, Algae, Flushing rate, Historical variation, Nutrients, Seasonal variation, Species composition, Temperature, Weather, Zooplankton.

The pattern of fluctuations in the total biomass and species composition of phytoplankton in the shallow, eutrophic Loch Leven exhibits considerable inter-annual and within-year variability. Nevertheless, studies over the 18-year period reviewed (1968-1985) show that many of the observed changes can be explained in terms of light regimes and the concentrations and fluxes of nutrients. On occasion, the incidence of fungal parasitism and of protozoan, rotiferan and crustacean grazing is also important. Changes in annual mean algal biomass from very high levels in the late 1960s and early 1970s to somewhat lower levels in the late 1970s, followed by occasional high peaks in the present decade, are attributed to shifts in phosphorus loading—particularly from a P-rich industrial source. In spite of complex and erratic sequences was algal species, seasonal patterns in the size distribution of the phytoplankton assemblage have been identified. The potential importance of the weather is highlighted as one of the possible causes of the irregular appearance of algal species. The influence of the weather on phytoplankton sequences is explored by comparing records of monthly flushing rate values with time-series data on aspects of the aquatic environment and plankton populations. The preliminary assessment suggests that variation

in flushing rate has a considerable effect on temperature regimes and the supplies and in-loch dynamics of nutrients; through such changes, flushing rate controls major features of phytoplankton succession such as temporal abundance of diatoms, as well as detailed sequences of events relating to the development and collapse of particular algal species--and, as a consequence, of the animals preying on them. (Author's abstract)
W90-07714

LONG-TERM INVESTIGATIONS OF TROPHIC RELATIONSHIPS IN SOUTHERN CHALK STREAMS.

Freshwater Biological Association, Ambleside (England). Windermere Lab.

M. Ladle.

Freshwater Biology FWBLAB, Vol. 23, No. 1, p 113-117, February 1990. 3 fig, 14 ref.

Descriptors: *England, *Monitoring, *Stream biota, Chalk streams, Field studies, Trophic level, Water chemistry.

Since the commencement of freshwater science in England, the understanding of the mechanisms by which producers and consumers interrelate has increased greatly. Information is required basically on three levels: (1) Short-term laboratory and field studies designed to provide detailed data on aspects such as habitat selection, growth, feeding behavior, etc.; (2) Investigation of patterns of change which show periodicities of weeks, months or even a few years associated with the life cycles of many plants and animals and with the seasonal variations in physical and chemical parameters; (3) Long-term surveillance and monitoring, often in a superficial manner, of particular aspects of river ecology in order to detect trends of change or patterns of variation over tens or hundreds of years and, if possible, to relate these to recorded climatic changes. Long-term data collection, in the scale of human longevity, is most appropriate to phenomena which show readily identifiable periodic maxima or minima or which occur at well defined times (for example the discharge of a river or the start and finish of flow in a winterbourne). Alternatively, information which is amenable to automatic or semi-automatic monitoring (temperature, water chemistry, fish migration) or integrated sampling (insect abundance, annual removal of cut water weeds) may also provide valuable evidence of long-term change. (Author's abstract)
W90-07715

NETWORK FOR LONG-TERM ECOLOGICAL RESEARCH IN THE UNITED STATES.

Wisconsin Univ.-Madison. Center for Limnology.

J. J. Magnuson, and C. J. Bowser.

Freshwater Biology FWBLAB, Vol. 23, No. 1, p 137-143, February 1990. 2 fig, 1 tab, 18 ref. NSF Grant BS8514330.

Descriptors: *Aquatic habitats, *Data acquisition, *Ecosystems, *Interdisciplinary studies, *Networks, *Research facilities, *United States, Ecological research, Lakes, Limnology, Playas, Streams, Wetlands.

A network of seventeen long-term ecological research (LTER) sites funded by the National Science Foundation (NSF) and spanning sites in arctic to tropical climates, low to high altitudes and wet to dry environments, provides evidence for the increasing popularity of sustained ecological research in the U.S.A. The sites function as regional or national facilities for long-term research as well as for comparative and process studies by investigators from the operating institutions and by visiting researchers. The aquatic habitats include a variety of lakes, ponds, wetlands, and a playa; montane, woodland, tundra and prairie streams; as well as salt marsh, estuary, ocean beach and inshore oceanic sites. By 1989 the interdisciplinary group of active researchers at the North Temperate Lakes LTER site had organized their research around the following objectives and principles: (1) to perceive and describe long-term trends and patterns in physical, chemical and biological properties of lake ecosystems; (2) to understand the dynamics of internal and external processes affecting

lake ecosystems; (3) to analyze the temporal responses of lake ecosystems to disturbance and stress; (4) to evaluate the interaction between spatial heterogeneity and temporal variability of lake ecosystems; and (5) to develop and test concepts and theories relating to temporal and spatial variability of lake ecosystems at scales relevant to long-term landscape ecology. (White-Reimer-PTT)
W90-07716

TEMPORAL COHERENCE IN THE LIMNOLOGY OF A SUITE OF LAKES IN WISCONSIN, U.S.A.

Wisconsin Univ.-Madison. Center for Limnology.

J. J. Magnuson, B. J. Benson, and T. K. Kratz.

Freshwater Biology FWBLAB, Vol. 23, No. 1, p 145-159, February 1990. 3 fig, 5 tab, 26 ref. NSF grants BSR8514330 and DEB9012313.

Descriptors: *Lakes, *Limnology, *Wisconsin, Chemical properties, Climates, Comparison studies, Model studies, Physical properties, Temporal coherence.

Temporal coherence between pairs of lakes over 7 years was measured for thirty-seven limnological variables in seven lakes at the North Temperate Lakes Long Term Ecological Research site in Northern Wisconsin. This analysis tested, first, whether lakes more similar in exposure to the atmosphere were more temporally coherent that lakes which differed more in exposure and, second, whether temporal coherence in lakes progressively decreased from variables more directly influenced by climatic factors such as thermal and hydrologic properties, to those chemical and biological properties which may be less directly influenced by climatic factors. Limnological variables formed a progression from those expected to respond directly to climatic factors to those which would not. They ranged from water level and temperatures to chemical variables such as pH, calcium concentrations and total dissolved phosphorus to biological variables such as chlorophyll concentrations, invertebrate and fish abundances. Coherence was estimated by the correlation between lake pairs for each of the different variables. Temporal coherence between lakes was higher for lakes similar in their exposure to climatic factors. None of the lake pairs had high coherence across all variables. Temporal coherence between lakes was greater for limnological variables directly influenced by climatic factors than for variables either indirectly affected by climate or complexly influenced by other types of factors. Coherence was not as strongly related to similarity in landscape position as it was to similarity in exposure to climatic factors, and was not related to the proximity of the lake pairs or to their similarity in fertility. A conceptual model is presented to explain how climatic signals are filtered by the lake's exposure to climatic factors and by terrestrially mediated and in-lake processes to reduce the coherence of lake pairs owing to time lags, frequency shifts and complex interference patterns. (Author's abstract)
W90-07717

INFLUENCE OF WOODY DEBRIS ON NUTRIENT RETENTION IN CATASTROPHICALLY DISTURBED STREAMS.

Mississippi Univ., University. Dept. of Biology.

N. G. Aumen, C. P. Hawkins, and S. V. Gregory.

Hydrobiologia HYDRB8, Vol. 190, No. 3, p 183-192, February 15, 1990. 4 fig, 2 tab, 26 ref. NSF grant BSR-8416127.

Descriptors: *Cycling nutrients, *Detritus, *Forest watersheds, *Stream biota, *Stream pollution, Chlorides, Nitrates, Nutrient retention, Phosphorus, Water pollution sources.

The role of woody debris in nutrient cycling was investigated in two catastrophically disturbed streams in the Pacific Northwest that had been subjected to large inputs of wood. One study site in each catchment had all woody debris removed (take section), while the debris in the other study site was left intact (leave section). Nitrate, phosphate and chloride (a conservative tracer) were released in each section and nutrient retention was

Group 2H—Lakes

monitored at downstream stations. Phosphate was removed from solution more than nitrate, probably due to the high N:P ratio in the stream water. However, there were no major differences in nutrient retention between the take and leave sections. In contrast, experiments in recirculating chambers showed that woody debris and cobbles exhibited higher nitrate and phosphate uptake per unit surface area than sand/gravel or fine particulate organic matter. The high uptake rates of woody debris and cobbles may be related to their suitability for colonization by heterotrophic microorganisms and algae. Wood may not influence nutrient retention significantly at the reach level because of its low surface area relative to other substrates. However, wood may be very important at small spatial scales because of its high uptake activity. (Author's abstract)
W90-07718

IMPACT OF INTENSIVE CAGE FISH FARMING ON THE PHYTOPLANKTON AND PERIPHYTON OF A SCOTTISH FRESHWATER LOCH.
Stirling Univ. (Scotland). Inst. of Aquaculture.
For primary bibliographic entry see Field 5B.
W90-07719

TOXIC CYANOBACTERIA (BLUE-GREEN ALGAE) IN FINNISH FRESH AND COASTAL WATERS.
Helsinki Univ. (Finland). Dept. of Microbiology.
For primary bibliographic entry see Field 5C.
W90-07721

EVALUATION OF FACTORS AFFECTING RESERVOIR YIELD ESTIMATES.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W90-07723

GROUNDWATER CONTROL OF CLOSED-BASIN LAKE LEVELS UNDER STEADY-STATE CONDITIONS.
Minnesota Univ., Minneapolis. Limnological Research Center.
For primary bibliographic entry see Field 2F.
W90-07727

DISSOLVED AMINO SUGARS IN THE RIMOV RESERVOIR (CZECHOSLOVAKIA).
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
J. Hejzlar, and C. Budejovice.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 291-301, 1989. 5 fig, 3 tab, 23 ref.

Descriptors: *Amino sugars, *Czechoslovakia, *Drinking water, *Limnology, *Storage reservoirs, Amino acids, Bacteria, Byproducts, Dissolved solids, Fucosamine, Galactosamine, Galacturonic acid, Glucosamine, Phytoplankton, Solutes, Spectrophotometry, Sugars.

Amino sugars are widespread in freshwater environments, in concentrations of the same order of magnitude as the concentrations of sugars in amino acids. Total dissolved amino sugars were determined in the drinking water reservoir Rimov, Czechoslovakia and its main tributaries by a modification of the Elson-Morgan spectrophotometric method. In the reservoir, concentrations of total dissolved amino sugars decreased to about 100 microgram/L during autumn overturn and winter stagnation and increased up to 280 microgram/L during summer stratification. During the summer months the concentrations of total dissolved amino acids in the epilimnion remained nearly constant due to equal production and decomposition rates of total dissolved amino sugars of about 5 to 10 microgram/L/day. Ion-exchange chromatography of amino sugars in soluble polymers isolated from the epilimnion revealed typical bacterial amino sugars (2-amino-2-deoxy-galacturonic acid, fucosamine, glucosamine and galactosamine). All of these amino sugars were found in five strains of bacteria cultivated from the reservoir. Besides bacteria,

phytoplankton (diatoms, cyanobacteria and green algae) seems to be another possible source of total dissolved amino sugars in the Rimov Reservoir. (Mertz-PTT)
W90-07736

HYDROCHEMISTRY AND PHYTOPLANKTON OF A MAJOR BLACKWATER RIVER (CARONI) AND A HYDROELECTRIC RESERVOIR (MACAGUA), VENEZUELA.
Fundacion La Salle de Ciencias Naturales, San Felix (Venezuela). Estacion Hidrobiologica de Guayana.
L. Sanchez, and E. Vasquez.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 303-313, 1989. 6 fig, 2 tab, 26 ref.

Descriptors: *Phytoplankton, *Reservoirs, *Rivers, *Venezuela, *Water chemistry, Acidic water, Bicarbonates, Caroni River, Cations, Conductivity, Dissolved oxygen, Hydroelectric power, Nitrates, Nitrites, Phosphorus, Population density, Transparency, Turbidity, Water quality, Water temperature.

Draining a portion of the Pre-Cambrian Guayana Shield, the Caroni River (Venezuela) is a large tributary of the Orinoco. The Caroni is also the site of important hydroelectric projects. In its lower section two dams were built (Guri and Macagua) and two more are planned. Additionally, Macagua dam will be enlarged. A 13-month investigation was initiated to survey hydrochemistry and phytoplankton of Macagua Reservoir, the river, and one adjacent shallow backwater. Results showed a mean water temperature of 28 C (range 26-29 C). Water was slightly acid (mean pH 6.12, range 5.28-6.77) with low dissolved chemical content (mean conductivity 9.2, range 6.6-11.0 microS/cm). Mean turbidity was 5.4 units (mg/L SiO2) (range 3.0-11.3 units as mg/L SiO2). Transparency was low (maximum 190 cm). Mean percentage concentration of dissolved oxygen was 75% (range 48-111%). Most common order of cations by concentration was Na>Ca>K>Mg. Bicarbonate ranged between 20-60 microequivalents/L. Nitrite and phosphate were not present in concentrations above the detection limits of the methods employed. Nitrate ranged between 38-140 microgram/L. Highest phytoplankton densities (12,020 organisms/L) were observed at low water (backwater station), the minimum density was 1022 organisms/L at high water (river station). Chlorophyta were dominant and phytoplankton did not show marked differences between stations. Seasonal variation was regulated by the flow regime of the river. In terms of water chemistry, the Caroni River presents similar characteristics to other blackwater rivers. (Author's abstract)
W90-07737

ORGANIC COMPOUNDS DISSOLVED IN WATER BODIES SITUATED IN AN AGRICULTURAL LANDSCAPE AND THEIR ROLE FOR MATTER MIGRATION.
Polish Academy of Sciences, Poznan. Dept. of Agrobiology and Forestry.
I. Zyczynska-Baloniak, and B. Szpakowska.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 315-322, 1989. 3 fig, 3 tab, 27 ref.

Descriptors: *Agricultural runoff, *Dissolved solids, *Limnology, *Path of pollutants, *Poland, *Reservoirs, *Soil organic matter, *Solute transport, Cations, Eutrophic lakes, Humic substances, Ion exchange, Minerals, Organic matter, Plankton, Polymictic lakes.

Organic compounds leached from soil of cultivated fields are strong ligands and play an important role in the migration of mineral constituents, introducing them into circulation. Reservoirs fed by field runoff often contain high concentrations of dissolved humic compounds. In well oxygenated water these compounds are resistant to biological decomposition and accumulate in reservoirs. Water from a lake in Poznan, Poland and its outflow channel was examined. Due to small depth and the location in an area open to winds, the lake is polymictic, and due to a large influx of nutrients from plants is eutrophic. Dissolved organic matter

in field water reservoirs was isolated and separated by means of Amberlite XAD-2 resin into components of soil and planktonic dissolved organic matter. It was shown that the soil dissolved organic matter components were more stable and had stronger chelating properties than those of planktonic origin. After acidification to pH 2 and separating on Amberlite XAD-2 resin, soil dissolved organic matter bound 62-79% more cations than planktonic dissolved organic matter. Therefore, in investigations into matter circulation in agro-ecosystems, compounds of soil origin play a significant role in the aquatic migration of mineral constituents. (Mertz-PTT)
W90-07738

REGULARITIES IN DISTRIBUTION AND MIGRATION FORMS OF HEAVY METALS IN LAKE SEVAN AND ITS TRIBUTARIES.
Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station.
For primary bibliographic entry see Field 5B.
W90-07742

SEDIMENTATION IN THE RIMOV RESERVOIR.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
For primary bibliographic entry see Field 2J.
W90-07743

CHANGES IN COMMUNITY STRUCTURE AND PRODUCTIVITY OF PHYTOPLANKTON AS INDICATORS OF LAKE AND RESERVOIR EUTROPHICATION.
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
I. S. Trifonova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 363-371, 1989. 2 fig, 2 tab, 23 ref.

Descriptors: *Bioindicators, *Eutrophication, *Lakes, *Phosphorus, *Phytoplankton, *Species composition, *Trophic level, *USSR, Algae, Aquatic productivity, Biomass, Chlorophyll a, Diatoms, Eutrophic lakes, Lake stages, Limnology, Mesotrophic lakes, Oligotrophic lakes, Primary production, Reservoirs.

The direct correlation between phytoplankton productivity and total phosphorus content was demonstrated for lakes of the north-west of the USSR. When the concentration of total phosphorus changes from 0.01 to 0.2 g/cubic m there is variation of 0.4-23 g/cubic m for phytoplankton biomass and 1.0-65 mg/cubic m for chlorophyll a content, as season averages, and 23-326 g C/square m for annual primary production. In the course of lake eutrophication there is change not only in indices of phytoplankton productivity but also in community structure and seasonal succession. Lake phytoplankton passes a number of stages from oligotrophy with predominance of cold-water flagellates and chrysophytes and one spring maximum of biomass, through several levels of mesotrophy with diatom predominance and 2-3 maxima, to eutrophy with predominance of blue-greens and dinoflagellates and an absence of biomass depression owing to nutrient limitation. In monitoring eutrophication the comparisons of mean annual or season-average values are of principal importance. It is possible also to use values for the most representative periods of the annual cycle. Thus the maximal seasonal values for oligotrophic lakes were recorded in spring and for eutrophic ones in summer. (Author's abstract)
W90-07745

PHYTOPLANKTON OF RESERVOIRS IN RELATION TO THE TROPHIC POTENTIAL OF INFLOW WATER.
Vyzkumny Ustav Vodohospodarsky, Brno (Czechoslovakia).
For primary bibliographic entry see Field 2E.
W90-07746

URBAN NUTRIENT INPUTS AND PHYTO-
PLANKTON BIOMASS IN A SMALL IM-
POUNDMENT ON THE RIVER MURRAY,
AUSTRALIA.
Murray-Darling Freshwater Research Centre,
Albury (Australia).
For primary bibliographic entry see Field 5B.
W90-07747

PHYTOPLANKTON OF THE RADUNIA
RIVER IN A CASCADE OF SMALL RESER-
VOIRS.
Research Inst. of Environmental Development,
Poznan (Poland).
R. Goldyn.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No.
2, p 389-396, 1989. 4 fig, 3 tab, 9 ref.

Descriptors: *Limnology, *Multireservoir net-
works, *Phytoplankton, *Reservoirs,
*Species composition, *Species diversity, Bacillar-
iophyceae, Chlorophyta, Chrysophtya, Cyano-
phyta, Euglenophycta, Nutrients, Population dy-
namics.

The Radunia is a small river crossing Kaszuby
Lake District in northern Poland. The investigated
reservoirs were located between 68 and 83 km
downstream from the source. In the cascade of the
three small reservoirs significant changes in the
quality and quantity of phytoplankton have been
found. The number of taxa within the reservoirs
was much higher than in the river above the
reservoirs (323 compared with 273 taxa). In the
reservoirs there were more taxa of Chlorophyceae,
Euglenophyceae, Chrysophyceae and Cyanophy-
ceae, but less of Bacillariophyceae. Changes in
quantitative data were different in summer and
winter. In winter a decrease in abundance of phy-
toplankton was observed along the river course
within the reservoirs. In summer significant in-
crease of abundance in the first reservoir, decrease
in the second and repeated slight increase in the
third reservoir were found. The main reason for
the changes of abundance of phytoplankton along
the cascade was the fertility of the water. Some
effect was exerted by the residence time of the
water and the growth of macrophytes in the reser-
voirs. (Mertz-PTT)
W90-07748

SEASONAL CHANGES OF PHYTOPLANKTON
DEVELOPMENT NEAR THE DAM OF THE
ZELIVKA-RESERVOIR (CZECHOSLOVAKIA).
Prazskevodarny-UHT, Narodnitrida 13, CS-1265
Praha 1, Czechoslovakia.
V. Houk.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No.
2, p 397-407, 1989. 6 fig, 3 tab, 7 ref.

Descriptors: *Czechoslovakia, *Phytoplankton,
*Reservoirs, *Species diversity, Asterionella, Aula-
cosira, Cyanophyta, Cyclotella, Diatoms, Fragi-
laria, Mesotrophic lakes, Reservoir operation, Sea-
sonal variation, Species composition, Stephanodis-
cus.

The water-supply Zelivka Reservoir in Czechoslo-
vakia was built to supply Prague with drinking
water. The first period of operation started in 1972
and the second in 1977, after the dam had been
completed and the reservoir was filled to final
capacity. Seasonal successions of phytoplankton
were investigated near the dam of the reservoir in
the first nine years of its operation at final capacity.
The sampling point was above the deepest part of
the reservoir, about 200 m from the dam. Samples
were collected in the growing seasons (March or
April) until late during 1977-1984. Seasonal succes-
sion of phytoplankton species was relatively regu-
lar, and corresponded to a mesotrophic type of
lake. During growing seasons five diatom species
(Asterionella formosa, Aulacosira italica, Cyclo-
tella comta, Fragilaria crotonensis and Stephano-
discus cf. hantzschii) usually dominated the phyto-
plankton, each reaching its maximum development
in a characteristic period. Relatively few species of
algae and blue-green algae were in the main part of
the phytoplankton biomass near the dam. (Mertz-
PTT)
W90-07749

SEASONAL DEVELOPMENT OF PHYTO-
PLANKTON IN SLAPY RESERVOIR WITH
SPECIAL ATTENTION TO THE SPRING
ALGAL PHASE.
Vyzkumny Ustav Vodohospodarsky, Prague
(Czechoslovakia).
R. Desortova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No.
2, p 409-417, 1989. 4 fig, 10 ref.

Descriptors: *Algae, *Czechoslovakia, *Limnolo-
gy, *Phytoplankton, *Population dynamics, *Res-
ervoirs, *Species composition, Algal growth, Bio-
mass, Chlorophyta, Cryptomonads, Cyanophyta,
Diatoms, Flagellates, Seasonal variation, Thermal
stratification, Transparency.

Long-term changes in algal biomass and species
composition were studied, based on eleven years of
sampling of the Slapy Reservoir (Czechoslovakia)
phytoplankton. Seasonal development of phyto-
plankton was characterized by several stages. A
spring pulse of cryptomonad growth and a subse-
quent stage of low algal biomass level, accompa-
nied by high transparency, were regularly ob-
served. Spring growth of phytoplankton regularly
started in late March or early April, and reached
the vernal peak at the end of April or during May.
Except for 1976 and 1985, the spring peak was also
the annual maximum of algal biomass. Phytoplank-
ton biomass was mostly dominated by a few spe-
cies of four major groups of algae: blue-green
algae, green algae, diatoms, and flagellates. The
development of thermal stratification in the reser-
voir was a major factor influencing the spring
outburst and following decline of cryptomonads.
(Mertz-PTT)
W90-07750

CHANGES OF PHYTOPLANKTON ASSEM-
BLAGE DURING THE SPRING PERIOD IN
THE MODERATELY EUTROPHIC RIMOV
RESERVOIR (CZECKOSLOVAKIA).
Ceskoslovenska Akademie Ved, Ceske Budejovice.
Inst. of Landscape Ecology.
J. Komarkova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No.
2, p 419-433, 1989. 5 fig, 3 tab, 48 ref.

Descriptors: *Biomass, *Chlorophyll a, *Czecho-
slovakia, *Eutrophic lakes, *Limnology, *Phos-
phorus, *Phytoplankton, *Reservoirs, *Species
composition, *Zooplankton, Bacillariophyceae,
Biovolume, Cryptophyceae, Flagellates, Lakes,
Seasonal variation, Volvocales.

During three spring seasons a study of phytoplank-
ton composition, biovolume-biomass and chloro-
phyll a concentration was made in relation to
physical conditions, phosphorus concentration and
herbivorous zooplankton abundance in the Rimov
reservoir (Czechoslovakia). The spring peaks of
phytoplankton appeared simultaneously with the
onset of the thermocline. Concentrations dropped
during the next two weeks to 2-10 mg/cubic m of
chlorophyll a with the onset of a clear water
phase. The species composition shifted from a
dominance of larger Cryptophyceae, Volvocales
and minute Bacillariophyceae to one of small flag-
ellates. From the second half of the clear water
phase, new algal species began to appear that were
able to cope with the predation pressure of phyto-
plankton feeders. The seasonality of phytoplankton
in the moderately eutrophic Rimov reservoir cor-
responds to a generalized model of seasonality
previously proposed. (Mertz-PTT)
W90-07751

GROWTH RATES OF PHYTOPLANKTON
POPULATIONS IN RIMOV RESERVOIR
(CZECHOSLOVAKIA) DURING THE SPRING
CLEAR-WATER PHASE.
Ceskoslovenska Akademie Ved, Ceske Budejovice.
Inst. of Landscape Ecology.
V. Vyhnalek.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No.
2, p 435-444, 1989. 4 fig, 1 tab, 22 ref.

Descriptors: *Algal growth, *Czechoslovakia,
*Diatoms, *Lakes, *Limnology, *Phytoplankton,
*Population dynamics, *Reservoirs, Cryptomon-

ads, Eutrophic lakes, Growth, Growth chambers,
Limiting nutrients, Phosphorus, Seasonal variation,
Zooplankton.

Growth rates of phytoplankton populations were
determined using dialysis chambers in the Rimov
reservoir (Czechoslovakia) in the spring of 1986.
Dialysis experiments were carried out from April
24 to June 16, 1986. The chambers were made of a
transparent plexiglass but with walls of the trans-
parent nitrocellulose membrane Cellophane.
Chambers were exposed at two depths, 0.3 and 0.6
m, for 3 or 4 days, with one exposition only for 6
days. Growth rates ranged between -0.58 and 0.91/
day. For diatoms only positive or zero values were
obtained, whereas cryptomonads often exhibited
negative growth rates in the chambers. Low
growth rates of the dominant species suggest nutri-
ent (phosphorus) limitation as the reason for phyto-
plankton collapse in the spring. In the course of the
clear-water phase phytoplankton populations grew
under control of nutrient (phosphorus) limitation
or zooplankton grazing. (Mertz-PTT)
W90-07752

METHOD FOR ESTIMATION OF PHYTO-
PLANKTON DARK LOSSES BY APPLICA-
TION OF 14C-TECHNIQUES.
Akademie der Wissenschaften der DDR, Berlin.
Inst. fuer Geographie und Geooekologie.
For primary bibliographic entry see Field 7B.
W90-07753

INFLUENCE OF LIGHT ON THE PRIMARY
PRODUCTION OF TWO PLANKTIC BLUE-
GREEN ALGAE.
Humboldt-Univ. zu Berlin (German D.R.). Sektion
Biologie.
A. Nicklisch, and J. G. Kohl.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No.
2, p 451-455, 1989. 3 fig, 2 tab, 8 ref.

Descriptors: *Algal growth, *Cyanophyta, *Light
effects, *Limnology, *Phytoplankton, *Primary
productivity, Aquatic productivity, Light penetra-
tion, Oscillatoria, Photoperiodism, Photosynthesis,
Reservoirs, Turbidity.

The primary production of an algal population can
be measured by the specific growth rate. It de-
pends not only on photon flux density, but also on
its spectral distribution, the length of photoperiod,
and on short fluctuations in photon flux density.
Two planktic blue-green algae, Oscillatoria redekei
and Oscillatoria agardhii, have different capabili-
ties to use low light and to adapt chromatically. If
the daylength is shortened, the utilization of low
light is not changed, but the maximum specific
growth rate is lowered in different degrees for the
two algae. Short light/dark cycles within the day
also cause a decrease of maximum specific growth
rate. The ability to meet competition under nutri-
ent saturation is therefore specifically changed by
both daylength and more frequent light fluctua-
tions. These responses to the time-structure of light
supply may be of importance for the development
and succession of mass populations of algae in
reservoirs, if the ratio of euphotic to mixed layer is
less than one. Slow mixing then decreases day-
length and turbulent mixing produces short light/
dark cycles. (Author's abstract)
W90-07754

ZOOPLANKTON POPULATION DYNAMICS
IN THE SANYATI BASIN, LAKE KARIBA,
ZIMBABWE.
Zimbabwe Univ., Harare. Lake Kariba Research
Station.
H. Masundire.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No.
2, p 469-473, 1989. 2 fig, 1 tab, 14 ref.

Descriptors: *Crustaceans, *Fish food organisms,
*Kariba Lake, *Limnology, *Population dynamics,
*Reservoirs, *Zimbabwe, *Zooplankton, Aquatic
populations, Bosmina, Ceriodaphnia, Copepods,
Diaphanosoma, Fish, Lakes, Mesocyclops, Moina,
Sardines, Species composition.

Group 2H—Lakes

Lake Kariba is a tropical man-made reservoir that was formed by the damming of the Zambezi River (Zimbabwe) in 1958. The lake is approximately 300 km long, with a mean width of 19.4 km. It is divided into five basins. A successful fishery has developed on the lake based on a sardine, Limnothrissa miodon, which was introduced in 1967-1968. The sardine is mainly zooplanktivorous. The temporal variations in abundance of crustacean zooplankton in Lake Kariba for the period July 1985 to July 1986 were investigated. Five Cladocerans were frequently encountered: Bosmina longirostris, Diaphanosoma excisum, Ceriodaphnia cornuta, Ceriodaphnia dubia, and Moina micrura. Of these, small Bosmina longirostris was the most dominant. Copepods were dominated by a small cyclopod, now tentatively identified as Mesocyclops ogunnus. Calanoids were never abundant. Two peaks in abundance were observed, one associated with the rainy season and the other associated with lake turnover. (Mertz-PTT)
W90-07756

ZOOBENTHOS IN RELATION TO ORGANIC MATTER IN LAKE SEVAN, USSR.
Institute for Water and Environmental Problems, Barnaul (USSR).
I. S. Ostrovsky.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 479-482, 1989. 4 tab, 3 ref.

Descriptors: *Armenia, *Benthic fauna, *Food chains, *Lakes, *Limnology, *Primary productivity, *USSR, Benthos, Biomass, Fish, Fish behavior, Hypolimnion, Invertebrates, Lake sediments, Lake stages, Leeches, Littoral zone, Midges, Oligochaetes, Organic matter, Oxygen depletion, Trophic level, Water level, Water level fluctuations.

Considerable changes of the trophic state of Lake Sevan (Armenia, USSR) were caused by a 19 m fall in water level. Primary production of Lake Sevan was raised by an order of magnitude during the period 1938-1978 as a result of marked water level changes. This increased the flux of organic material to the bottom sediments. Consequently, a sixfold increase in the biomass of benthic invertebrates occurred. The relative biomass of detritivores and filter feeders (midges, oligochaetes, and snails) feeding on detritus in the sediments increased, while predator relative biomass decreased (leeches, dragonflies, and midges). Midges and oligochaetes which were able to tolerate depressed oxygen levels in the hypolimnion became dominant in the benthos. There was a decrease of littoral phytophilous and lithophilous animals (leeches, mayfly and dragonfly nymphs, and amphipods) due to the reduction of the area of their biotopes. During the period 1978-1983, there was a threefold decrease in primary production. At the same time the fishes feeding at depths of 0-20 m increased their feeding pressure on the benthos. Those invertebrates most accessible to fish (amphipods, leeches, and mayfly larvae) showed the largest quantitative decrease. (Mertz-PTT)
W90-07757

ECOTOXICOLOGICAL TESTS ON BENTHIC ORGANISMS.
Procter and Gamble European Technical Center, Brussels (Belgium).
For primary bibliographic entry see Field 5C.
W90-07758

EFFECT OF ZOOPLANKTON ON PHOSPHORUS CYCLING IN MAN-MADE LAKE ZEGRIZYNSKIE.
Polish Academy of Sciences, Mikolajki. Inst. of Ecology.
J. Ejsmont-Karabin, M. Bubien, and T. Weglenska.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 493-501, 1989. 6 fig, 1 tab, 7 ref.

Descriptors: *Cycling nutrients, *Limnology, *Phosphorus, *Poland, *Reservoirs, *Zooplankton, Biomass, Detritiophagous zooplankton, Detritus, Nutrient transport, Phytoplankton, Population density, Seasonal variation, Sedimentation.

Damming of rivers enhances the removal of nutrients from water, especially if primary reservoirs

are constructed or if they form a cascade. Materials were collected at 8 stations in Lake Zegrzynskie, Poland, in May and August, 1984. The effects of zooplankton on nutrient cycling were compared in two phenological periods: in spring, when the role of zooplankton is much smaller, and in summer, when detritophagous zooplankton is abundant and turnover time of phosphorus is very short as a result of its recycling by zooplankton. Zooplankton seem to have an important effect on phosphorus sedimentation in Lake Zegrzynskie. Zooplankton occurrence, and especially the abundance of small detritiophagous species largely counteract this process. Phosphorus sedimentation is thus possible only in places and periods with low zooplankton densities and the dominance of larger phytophagous forms in it, preventing the recycling of a part of phosphorus contained in the biomass of phytoplankton and zooplankton, and also in detritus. (Mertz-PTT)
W90-07759

TEMPERATURE INCREASE EFFECTS ON ZOOPLANKTON STRUCTURE IN A COOLING RESERVOIR.
LIMNOS S.A., Barcelona (Spain).
For primary bibliographic entry see Field 5C.
W90-07760

ZOOPLANKTON COMPOSITION AND ABUNDANCE IN RELATION TO WATER TRANSPARENCY AND PREDATION IN LAKE KARIBA, ZIMBABWE.
Zimbabwe Univ., Harare. Lake Kariba Research Station.
H. Masundire.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 513-520, 1989. 2 fig, 1 tab, 32 ref.

Descriptors: *Fish food organisms, *Kariba Lake, *Lakes, *Limnology, *Predation, *Species composition, *Transparency, *Zimbabwe, *Zooplankton, Copepods, Cyanophyta, Phytoplankton, Population density, Rotifers, Sardines, Water temperature effects, Waterfleas.

Zooplankton were collected in Lake Karbia, Zimbabwe, between March 1986 and March 1987. More than 40 species of rotifers, 9 cladocerans, and at least 4 cyclopoids and 3 calanoids were found. The five basins of the lake differed little qualitatively, but showed large quantitative differences. Zooplankton abundances decreased along the lake axis from the entry of the Zambezi River to the dam wall. The Sanyati River, a major tributary, had a significant effect on the zooplankton abundance in basin V. Transparency was lowest in the basins with highest zooplankton abundances. This effect could be via the main pelagic predator of the zooplankton, Limnothrissa miodon. This fish was introduced 20 years ago. Food may also be a factor limiting zooplankton abundance. Phytoplankton is dominated by blue-green algae. Some blue-green algae are thought to be toxic to zooplankton although there is now strong evidence that zooplankton do utilize some blue-green algae as food. Generally the zooplankton of Lake Kariba are small in size. This may be due to the high temperatures, which exceed 22 C in the top 20 m for more than 8 months of the year. Food availability and food quality also influence zooplankton size. Predation by Limnothrissa miodon, may also have caused a reduction in zooplankton size. The mean size of Bosmina longirostris in Lake Kariba is 290 micrometers, while in the more eutrophic Lake McIllwaine the mean size is 442 micrometers. Thus it is possible that the strategy for survival has been for the zooplankton in Lake Kariba to reduce size. (Mertz-PTT)
W90-07761

ZOOPLANKTON SPECIES DYNAMICS DURING IMPOUNDMENT AND STABILIZATION IN A SUBARCTIC RESERVOIR.
Montreal Univ. (Quebec). Dept. of Biological Sciences.
B. Pinel-Alloul, G. Methot, and M. Florescu.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 521-537, 1989. 9 fig, 2 tab, 35 ref.

Descriptors: *Canada, *Limnology, *Reservoirs, *Species composition, *Zooplankton, Crustaceans, Food habits, Hydroelectric power, Population dynamics, Postimpoundment, Rotifers, Subarctic reservoirs, Succession, Trophic level.

The completion of a hydroelectric project in the James Bay area, Canada, provided an opportunity to investigate the zooplankton community of subarctic reservoirs in the early years of impoundment. The long term succession of zooplankton species and the relationships with the fluctuations in water quality and trophic parameters in the newly impounded subarctic reservoir were examined between 1978 and 1984. The structure and dynamics of the dominant zooplankton populations showed highly different variation patterns in inundated lakes and rivers as compared to the blank lake station. Rotifer predominance after the filling of the reservoir may be attributable to their detrital feeding mechanisms. Thus the initial response of rotifers of different trophic requirements can be a good indicator of the trophic upsurge process. The succession and dominance of microfilter-feeder crustaceans is also related to hydrological and trophic factors and can be linked to the maturation processes of the new reservoir. (Mertz-PTT)
W90-07762

FAUNA OF THE ZEMBORZYCE RESERVOIR.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
For primary bibliographic entry see Field 5C.
W90-07763

FATE OF ZOOPLANKTON IN A RIVER AFTER LEAVING A DAM RESERVOIR.
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
R. Zurek, and E. Dumnicka.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 549-561, 1989. 9 fig, 1 tab, 16 ref.

Descriptors: *Dam effects, *Limnology, *Poland, *Reservoirs, *Rivers, *Zooplankton, Benthos, Biomass, Elimination coefficient, Food chains, Population density.

Investigations of the fate of zooplankton after leaving a dam reservoir were made on a 7 km sector of the River Dunajec (Poland) at discharges of 4, 180, and 240 cubic m/second. At a discharge of 4 cubic m/sec the processes of zooplankton elimination are very distinct. The elimination coefficients for particular species vary from 0.0127 to 0.000226. At such discharges, after 7 km the benthos communities eliminate 37.95 kg dry weight of zooplankton of the 40.06 kg falling daily into the river. On the first kilometer 0.239 g of dry zooplankton weight is eliminated on 1 square m of the bottom. The mean daily elimination is 0.0952 g dry weight. At high discharges, low zooplankton concentrations were recorded at stations close to the dam. They increased with distance. In order to explain this, a hypothesis was put forward that sinking to the bottom was a behavior by the zooplankton when a sudden change of conditions occurred after leaving the reservoir. After the shock effect wore off, most of the animals returned to higher layers of the water and were again recorded. Predators and detritivores dominated in the rich bottom communities. (Author's abstract)
W90-07764

CHANGES IN FISH COMMUNITIES AND BIOMANIPULATION IN WATER SUPPLY RESERVOIRS.
Vyzkumny Ustav Rybarsky Vodnany (Czechoslovakia). Reservoir and River Lab.
J. Vostradovsky, J. Krizek, O. Albertova, L. Ruzicka, and M. Vostradovska.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 587-594, 1989. 4 fig, 2 tab, 15 ref.

Descriptors: *Czechoslovakia, *Fish management, *Reservoir operation, *Species composition, Carp, Environmental effects, Fish populations, Fish stocking, Lake stages, Planktivorous fish, Population dynamics, Predation, Reservoir stages, Reser-

voirs, Succession, Walleyes, Water level, Water supply.

A biomanipulation system aimed at creating better environmental conditions by water supply management was introduced in 42 Czechoslovakian water supply reservoirs. The development of ichthyofauna in all the studied newly filled reservoirs depended on the species composition of the autochthonous stock in the drainage area of the reservoir. Fish species successions induced by changes in the environment of the water supply reservoirs built mostly in the headwaters of brooks and rivers (trout streams) can be considered as typical of central Europe. Development in these reservoirs could be characterized by three stages, each with its dominant fish species: (1)salmonids; (2) perch; and (3) cyprinids. The effort to keep the reservoirs in the first stage of succession as long as possible was the main practical goal of this study. In the reservoirs which had reached the second and third stages, effort was made to stop the natural course of development and turn it back towards the initial stage. Single interventions such as manipulation of the water level or of fishing load lead only to temporary stopping of the occurrence of planktivorous fishes; the range of the effectiveness of such interventions is limited, and dependent on the fish species. Preference should be given to stocking the predatory species, species whose natural reproduction can be controlled and which contribute to the reduction of planktivores. Stocking with pike perch (Stizostedion lucioperca) and rapacious carp (Aspius aspius) seems promising. (Mertz-PTT)
W90-07765

SEASONAL CHANGES OF ZOOPLANKTON AND PHYTOPLANKTON AND THEIR MUTUAL RELATIONS IN SOME CZECHOSLOVAK RESERVOIRS.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
Z. Brandl, B. Desortova, J. Hrbacek, J. Komarkova, and V. Vyhnalek.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 597-604, 1989. 3 fig, 1 tab, 17 ref.

Descriptors: *Czechoslovakia, *Food chains, *Limnology, *Phytoplankton, *Population dynamics, *Reservoirs, *Zooplankton, Algal blooms, Biomass, Bosmina, Chlorophyll a, Copepods, Cyanophyta, Daphnia, Predation, Rotifers, Seasonal variation, Species composition, Transparency, Waterfleas.

Seasonal changes of the species structure and the amount of zooplankton and phytoplankton are evaluated in nine Czechoslovak reservoirs of different size, depth and retention time, monitored in various extent during the last 30 years. They exhibited a similar course of regular events including spring algal bloom of small-cell species, the spring increase of zooplankton starting with a pulse of copepods and rotifers and followed later by the development of cladoceran populations coinciding with a deep, and usually short, depression of phytoplankton. The further development of summer phytoplankton is based on large-cell or colonial species and eventually results in the heavy summer or autumn blooms of blue-greens or diatoms. The summer fluctuations of zooplankton biomass usually do not achieve the spring maximum. Eight reservoirs had a similar zooplankton structure with Daphnia galeata, Bosmina longirostris and Cyclops vicinus as main species. Only the reservoir stocked with predatory fish in low density had the large cladoceran Daphnia pulicaria as the main species, together with a high transparency and a low chlorophyll a content. (Author's abstract)
W90-07766

ZOOPLANKTON STRUCTURE AND FISH POPULATION DEVELOPMENT IN THE RIMOV RESERVOIR, CZECHOSLOVAKIA.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
J. Seda, J. Kubecka, and Z. Brandl.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 605-609, 1989. 2 fig, 2 tab, 13 ref.

Descriptors: *Czechoslovakia, *Fish food organisms, *Fish populations, *Limnology, *Reser-

voirs, *Zooplankton, Biomass, Cladocerans, Fish physiology, Planktivorous fish, Population dynamics, Reservoir fisheries, Species composition, Waterfleas.

The relationships between the parameters characterizing the fish populations in the Rimov Reservoir, Czechoslovakia, (fish biomass, the calculated fish metabolic activity) and the parameter characterizing the zooplankton composition and the size structure were examined. Zooplankton was monitored in three-week intervals at one station situated near the dam of the reservoir by means of vertical hauls with the Apstein net. From the examined relations, two conclusions can be drawn: (1) Large cladocerans, representing the main herbivorous component of zooplankton, are most sensitive to the increased predatory impact of planktivorous fish. They can be a significant component of the zooplankton assemblage only if the fish biomass is low (less than 100 kg/hectare); and (2) This relation between the fish biomass and the size structure of zooplankton can be used to evaluate the fish stock of the reservoir indirectly according to the information on the zooplankton size structure and composition. (Mertz-PTT)
W90-07767

DEVELOPMENT OF THE ICHTHYOFAUNA OF THE RIMOV RESERVOIR AND ITS MANAGEMENT.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
J. Kubacka.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 611-613, 1989. 7 ref.

Descriptors: *Czechoslovakia, *Fish management, *Fish populations, *Reservoirs, Biomass, Bream, Cyprinids, Lake fisheries, Perch, Roach, Salmon, Succession.

The development of the fish stock of the Rimov Reservoir in Czechoslovakia was the result of the natural development of the autochthonous fishes and of the management. After a short salmonid and esocid phase of development, strong populations of perch, roach and bream had built up. Limiting the recruitment from 1982 by drying of eggs and, in the case of perch, by very strong cannibalism and other factors, caused the decline of the biomass of three main planktivores. The development of the fish fauna of the Rimov reservoir has not reached the climax state with the dominance of cyprinids. The coexistence of perciform and cyprinid stock with a low biomass (below 200 kg/hectare) is a desirable outcome resulting from successful reservoir management. (Mertz-PTT)
W90-07768

MAIN FACTORS AFFECTING SPRING DEVELOPMENT OF HERBIVOROUS CLADOCERA IN THE RIMOV RESERVOIR (CZECHOSLOVAKIA).
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
J. Seda.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 619-630, 1989. 9 fig, 22 ref.

Descriptors: *Czechoslovakia, *Food chains, *Limnology, *Phytoplankton, *Population dynamics, *Reproduction, *Reservoirs, *Waterfleas, *Zooplankton, Aquatic productivity, Bosmina, Daphnia, Epilimnion, Fecundity, Lake stratification, Seasonal variation, Water temperature.

The regular pattern of spring succession of phytoplankton and herbivorous Cladocera in the Rimov reservoir, Czechoslovakia, provides an ideal model for population dynamics study. The cladoceran populations consist only of Daphnia galeata and Bosmina longirostris in this reservoir during the spring period (the period from ice melting to clear water phase establishment). Close synchronization of reproduction parameters of both cladoceran species with phytoplankton dynamics was observed. The spring peak of fecundity of D. galeata and B. longirostris was the maximum value of the whole year. Not only the peak of fecundity (eggs per adult female), but the absolute numbers (eggs per

square m) showed a maximum in this period, too. In the short period immediately after ice melt,when the reservoir temperature is homogeneous at 4C, the population density of cladocerans is always very low. During the period until the surface water attains a temperature of about 10 C and temperature stratification starts the phytoplankton increased exponentially until the period of stable epilimnion separation. The period of stable epilimnion until the point when the average water temperature reached about 13 C coincided with cladoceran population concentrations in the epilimnion water layers. The density of cladoceran populations reached the annual maximum plateau and the intensity of their reproduction was reduced during the period until the minima of phytoplankton and average epilimnion temperature of about 18 C. (Mertz-PTT)
W90-07769

ORIGIN, COMPOSITION AND YIELD OF FISH IN RESERVOIRS.
Waterloo Univ. (Ontario). Dept. of Biology.
C. H. Fernando, and J. Holcik.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 637-641, 1989. 11 ref.

Descriptors: *Adaptation, *Aquatic habitats, *Fish harvest, *Reservoirs, *Species composition, *Succession, Fish management, Fish populations, Fish stocking, Lacustrine environment, Pelagic fish, Reservoir operation.

In all reservoirs the fish fauna is recruited from riverine antecedents. Due to the unstable hydrological regime of rivers the nature of their environment favors the evolution of euryoecious species which are usually ill adapted to lacustrine conditions. When riverine fish communities are trapped in a reservoir, most of the fishes stay close to the shores, the mouth of tributaries and in shallows. The pelagic and deep waters are poorly utilized and the yield of fish is below the natural productivity of these water bodies, unless the dammed river contains fish species from families preadapted for lacustrine conditions. There is a direct correlation between the percentage of pelagic fish and fish yield in reservoirs. This situation probably applies to the littoral and deep water region of reservoirs too, although sufficient data to demonstrate this are not available at the present time. If such preadapted lacustrine species are not present, the introduction of lacustrine species or those preadapted for lacustrine environment is desirable under certain circumstances. However, caution must be exercised in any introduction. (Author's abstract)
W90-07770

DRIFT OF AQUATIC INSECTS FOLLOWING METHOXYCHLOR TREATMENT OF THE SASKACHEWAN RIVER SYSTEM.
Saskatchewan Univ., Saskatoon. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-07820

FINITE ELEMENT SOLUTION OF THE SHALLOW-WATER WAVE EQUATIONS.
Norsk Hydroteknisk Lab., Trondheim.
For primary bibliographic entry see Field 7C.
W90-07863

NITROGEN FIXATION DYNAMICS OF TWO DIAZOTROPHIC COMMUNITIES IN MONO LAKE, CALIFORNIA.
Geological Survey, Menlo Park, CA.
R. S. Oremland.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 3, p 614-622, March 1990. 6 fig, 4 tab, 38 ref.

Descriptors: *Aquatic bacteria, *California, *Lakes, *Limnology, *Mono Lake, *Nitrogen fixation, *Nitrogen fixing bacteria, *Saline lakes, Algae, Ammonia, Chlorophyta, Cyanophyta, Enzymes, Littoral zone, Nitrates, Oxygen, Photoactivation, Photochemistry, Seasonal variation, Sulfides.

Group 2H—Lakes

Two types of diazotrophic microbial communities were found in the littoral zone of alkaline hypersaline Mono Lake, California. One consisted of anaerobic bacteria inhabiting the flocculent surface layers of sediments. Nitrogen fixation (acetylene reduction) in these layers occurred under anaerobic conditions, was not stimulated by light or by additions of organic substrates, and was inhibited by oxygen, nitrate, and ammonia. The second community consisted of a ball-shaped association of a filamentous chlorophyte (Ctenocladus circinnatus) with diazotrophic, nonheterocystous cyanobacteria, as well as anaerobic bacteria (Ctenocladus balls). Nitrogen fixation by Ctenocladus balls was usually, but not always, stimulated by light. Rates of anaerobic dark fixation equaled those in the light under air. Fixation in the light was stimulated by 3-(3,4-dichlorophenyl)-1,1-dimethylurea (DCMU) and by propanil (N-(3,4-dichlorophenyl)propanamide). DCMU-elicited nitrogenase activity was inhibited by ammonia (96%) and nitrate (65%). Fixation was greatest when Ctenocladus balls were incubated anaerobically in the light with sulfide. Dark anaerobic fixation was not stimulated by organic substrates in short-term (4-h) incubations, but was in long-term (67-h) ones. Areal estimates of benthic nitrogen fixation were measured seasonally, using chambers. Highest rates (about 29.3 micromoles of acetylene/sq m/h) occurred under normal diel regimens of light and dark. These estimates indicate that benthic nitrogen fixation has the potential to be a significant nitrogen source in Mono Lake. (Author's abstract)
W90-07865

EFFECT OF WEATHER VARIABILITY ON THE ENERGY BALANCE OF A LAKE IN THE HUDSON BAY LOWLANDS, CANADA.
York Univ., North York (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2D.
W90-07875

MONITORING FLORIDA'S RIVERINE FISH COMMUNITIES.
Florida Game and Fresh Water Fish Commission, Holt. Blackwater Fisheries Research and Development Center.
For primary bibliographic entry see Field 8I.
W90-07876

USING MINNOW TRAPS TO ESTIMATE FISH POPULATION SIZE: THE IMPORTANCE OF SPATIAL DISTRIBUTION AND RELATIVE SPECIES ABUNDANCE.
Wisconsin Univ.-Madison. Center for Limnology.
X. He, and D. M. Lodge.
Hydrobiologia HYDRB8, Vol. 190, No. 1, p 9-14, February 1990. 5 fig, 17 ref. NSF Grant BMS-83-08919.

Descriptors: *Data acquisition, *Distribution patterns, *Fish populations, *Lakes, Bogs, Dace, Michigan, Mudminnow, Population density, Sampling, Tuesday Lake.

Relative abundance and within-lake distributions of three fishes, northern redbelly dace (Phoxinus eos), finescale dace (P. neogaeus), and central mudminnow (Umbra limi), were examined using minnow traps in Tuesday Lake, a small bog lake in the Upper Peninsula, Michigan. For these species, catches in minnow traps placed at the perimeter of the lake were 21-52 times higher than catches in midlake traps. Variance:mean ratios of perimeter trap catches indicated that both dace species were highly aggregated while the distribution of mudminnows was less aggregated or random. Over an 11 day period during which all fish caught were removed from the lake, catch per unit effort (CPUE) of both dace species declined in response to fish removal. In contrast, CPUE for mudminnows was low initially, increased to an asymptote and then declined only in the last 5 days of the fish removal. The patterns of CPUE for mudminnows indicated that mudminnow trapability and/or activity was reduced in the presence of high densities of dace. The low abundance of dace in traps with many mudminnows suggested mudminnows avoided traps already containing dace. Throughout the

removal period, CPUE provided an accurate index of dace abundance, whereas this was true for mudminnows only after dace populations had been reduced drastically. Therefore, in any use of minnow traps to estimate populations, both spatial distributions and relative abundance of small fishes must be taken into account. (Author's abstract)
W90-07879

COMPOSITION AND DYNAMICS OF A HIGHLY DIVERSE DIATOM ASSEMBLAGE IN A LIMESTONE STREAM.
Dept. d'Ecologia, Avgda, Diagonal 645, 08028 Barcelona, Spain.
S. Sabater.
Hydrobiologia HYDRB8, Vol. 190, No. 1, p 43-53, February 1990. 4 fig, 2 tab, 33 ref.

Descriptors: *Algae, *Diatoms, *Population dynamics, *Streams, Chlorophyll, Mineralization, Salinity, Seasonal variation, Species diversity.

The algal assemblages of a small limestone stream were studied for a year at monthly intervals. Algal standing crop was permanently high (mean concentration of 158 mg Chlorophyll-a/sq m), but it reached the maximum values in spring and summer. Diatoms were dominant in the algal assemblages throughout this time, and more than 100 species were recorded during the survey. Most of them are characteristic of hard waters, but others, mainly occurring in summer, have been observed elsewhere in moderately halophile waters. A striking succession was observed in the diatom assemblage in the stream in each season. This succession, with a maximum in summer, was mainly related with the lessening in flow and the increase in water mineralization. Moreover, the diversity of the samples increased sharply from April 1982 to July 1983. In fact, a progressive increase in salinity tolerant species could be observed from winter and spring to summer. Nitzschia sociabilis, Navicula gregaria, N. lanceolata and Gomphonema olivaceum were the most abundant species in winter, whereas Achnanthes minutissima reached its maximum in spring and Navicula schroeterii, Nitzschia thermaloides and Cyclotella meneghiniana were some of the most abundant in summer. (Author's abstract)
W90-07880

EFFECT OF ALUMINUM IN SOFT WATER AT LOW PH ON OXYGEN CONSUMPTION BY THE DRAGONFLY LIBELLULA JULIA UHLER.
Massachusetts Univ., Amherst. Dept. of Environmental Sciences.
J. P. Rockwood, D. S. Jones, and R. A. Coler.
Hydrobiologia HYDRB8, Vol. 190, No. 1, p 55-59, February 1990. 2 fig, 26 ref. Massachusetts Experiment Station Project Hatch No. 580.

Descriptors: *Acid rain effects, *Aluminum, *Aquatic insects, *Dragonflies, Acidic water, Hydrogen ion concentration, Oxygen requirements.

The effects of the direction of change and the relative importance of low pH were compared to the combined effects of Al and low pH dragonfly. As a consequence of elevated H(+) and Al concentrations, significantly depressed oxygen consumption (p < 0.01) was observed among treatments in dragonfly nymphs. Although the mean oxygen uptake was reduced by 28% in acidified control water (pH 4.0, 0.02 mg Al/l) and by 36% at pH 4.0 and 0.3 mg/l relative to control rates, these differences were not significant. Reductions significantly different (p < 0.05) from the control were observed with Al concentrations of 3.0 and 30 mg/l (54% and 75%). Both the acidified control and the 0.3 mg/l treatments differed significantly from the 30 mg/l treatment. Low pH (4.0) alone, therefore, does not appear to inhibit oxygen uptake as markedly as when it occurs in conjunction with Al in concentrations of 3 mg/l or greater. (Sand-PTT)
W90-07881

FISH COMMUNITY STRUCTURE, SPATIAL DISTRIBUTION AND FEEDING ECOLOGY IN A BEAVER POND.

Queen's Univ., Kingston (Ontario). Dept. of Biology.
A. Keast, and M. G. Fox.
Environmental Biology of Fishes EBFID3, Vol. 27, No. 3, p 201-214, March 1990. 6 fig, 5 tab, 41 ref.

Descriptors: *Beavers, *Fish populations, *Lake fisheries, *Limnology, *Ponds, *Species diversity, Fish diets, Habitats, Population density, Resource partitioning.

The fish community of a small (2.7 ha) Ontario beaver pond was analyzed relative to predictions based on its small size, shallow depth, brief existence and isolation from more permanent water bodies. The predictions were: (1) species richness will be lower than that of more permanent water bodies in the area, (2) fish will be mainly of small body size, (3) species will be randomly distributed across habitats, and (4) there will be a high degree of diet overlap between species and age classes. The first and second predictions were supported. The pond consisted of 10 resident species in 1985, and at least seven in 1988. Species richness was below the average of 13.2 found in four lakes in the vicinity, but greater than the 3.1 predicted by a species-area curve for non-acidified lakes in Ontario. All species except pumpkinseed, yellow perch and brown bullheads were small-bodied with short life spans and high population turnover rates, and few fish above 100 mm were present. Predictions 3 and 4 were not supported. Habitat occupation was nonrandom, and high diet separation occurred, particularly in August when food limitation was evident. While beaver ponds lack the range of habitats and the diversity of species of lake environments, low prey density and high fish density nevertheless appear to foster resource partitioning. (Author's abstract)
W90-07902

IMPACTS OF LOG STORAGE UPON EPILIMNETIC DISSOLVED OXYGEN AND JUVENILE SOCKEYE SALMON IN BABINE LAKE, BRITISH COLUMBIA.
British Columbia Univ., Vancouver. Westwater Research Centre.
For primary bibliographic entry see Field 5C.
W90-07916

ORGANIC MATTER DEGRADATION AND NUTRIENT REGENERATION IN AUSTRALIAN FRESHWATERS: II. SPATIAL AND TEMPORAL VARIATION, AND RELATION WITH ENVIRONMENTAL CONDITIONS.
Murray-Darling Freshwater Research Centre, Albury (Australia).
For primary bibliographic entry see Field 2E.
W90-07956

LIMNOLOGICAL STUDY OF LAKE TODOS LOS SANTOS (CHILE): MORPHOMETRY, PHYSICS, CHEMISTRY, PLANKTON, AND PRIMARY PRODUCTIVITY.
Universidad Austral de Chile, Valdivia. Inst. de Zoologia.
H. Campos, W. Steffen, G. Aguero, O. Parra, and L. Zuniga.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 4, p 453-484, February 1990. 15 fig, 7 tab, 25 ref. National Research Fund Grant 263-82. Research Direction of the Universidat Austral de Chile Grant RS-83-49.

Descriptors: *Lake morphometry, *Limnology, *Oligotrophic lakes, *Plankton, *Primary productivity, *Water chemistry, Biomass, Chile, Chlorophyll, Nutrients, Thermal stratification, Zooplankton.

Lake Todos los Santos, an oligotrophic lake of volcanic origin, lies 189 m above sea level and has a surface area of 178.5 sq km. A bathymetric survey showed a deep basin (337 m maximum depth) as well as great volume (34.4 cu km). The drainage area is 17 times its surface area. According to its physical and chemical factors, this lake is monomictic temperate with winter circulation at

8.1 C and thermal stratification in summer. Transparency is high (10.2 m, Secchi disk). The main nutrients are in low concentration, with a vertical distribution nearly homogeneous during winter circulation and with an orthograde tendency during thermal stratification. The availability of these nutrients correlated to higher abundances in phytoplanktonic biomass. The greatest carbon assimilation per chlorophyll unit occurred in winter although the primary productivity reached its highest level at the beginning of summer. The levels of primary productivity were low. Phytoplankton had a maximum in spring (October), belonging mainly to the species Rhizosolenia eriensis, Cyclotella stelligera, Closterium acutum var. variabile, and Sphaerocystis schroenteri. Diatoms are abundant in winter-spring, Chlorophyceae in spring, Cyanophyceae in winter and beginning of spring. A species of calanoid copepod, Boeckella gracilipes, was identified in the zooplankton, together with one species of cyclopoid copepod, Mesocyclops longisetus, two species of Cladocera, Eubosmina hagmanni and Daphnia pulex, and nine species of rotifera, dominated by Synchaeta stylata and Conochilus unicornis. The abundance maxima of the zooplankton coincided with those of the phytoplankton. The highest abundance was observed at the beginning of summer. The phytoplanktonic composition was determined not only by nutrient availability, but by thermal variations. (Geiger-PTT)
W90-07958

INDIRECT DETECTION OF SUBSURFACE OUTFLOW FROM A RIFT VALLEY LAKE.
British Geological Survey, Wallingford (England). W. G. Darling, D. J. Allen, and H. Armannsson. Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 297-306, February 1990. 5 fig, 14 ref.

Descriptors: *Closed lakes, *Kenya, *Subsurface drainage, *Subsurface mapping, Geothermal water, Lake evaporation, Stable isotopes, Water level fluctuations.

Naivasha, highest of the Kenya (Gregory) Rift Valley lakes, has no surface outlet. However, unlike other Rift lakes it has not become saline despite high potential evaporation rates, which indicates that there must be some subsurface drainage. The fate of this outflow has been the subject of speculation for many years, especially during the general decline in lake water level during the 1980's. To the south of the lake, there are few opportunities to obtain information from direct groundwater sampling. However, the stable isotopic composition of fumarole steam from late Quaternary volcanic centers in the area has been used to infer groundwater composition. Using a simple mixing model between Rift-flank groundwater and highly-evaporated lake water, has enabled the subsurface water flow to be contoured by its lake water content. By this method, outflow can still be detected some 30 km to the south of the lake. Stable isotope data also confirm that much of the steam used by the local Olkaria geothermal power station is derived from lake water, though simple balance considerations show that steam use cannot alone be responsible for the fall in lake level observed during the 1980's. (Author's abstract)
W90-07991

ZOOPLANKTON ABUNDANCE AND EVIDENCE FOR ITS REDUCTION BY MACROPHYTE MATS IN TWO ORINOCO FLOODPLAIN LAKES.
Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology. S. K. Hamilton, S. J. Sippel, W. M. Lewis, and J. F. Saunders. Journal of Plankton Research JPLRD9, Vol. 12, No. 2, p 345-363, March 1990. 8 fig, 2 tab, 33 ref. NSF grant BSR 83-15410.

Descriptors: *Floating plants, *Flood plains, *Lakes, *Limnology, *Macrophytes, *Orinoco River, *Zooplankton, Benthic environment, Copepods, Crustaceans, Food chains, Hydraulic residence time, Lake Aguilera, Lake Tineo, Lake morphology, Periphyton, Population density, Rotifers, Seasonal variation, Tropical regions, Venezuela.

Zooplankton populations were sampled over one annual cycle in two floodplain lakes of the Orinoco River, Venezuela, in an attempt to establish the relationship between abundance patterns and the hydrology and morphometry of the lakes. One of the lakes (Tineo) is relatively large with a gently sloping basin; the other one (Aguilera) is smaller and channel-shaped. The hydraulic residence time of Lake Aguilera during inundation by the river is shorter (<1 day) than the minimum generation times of crustacean (4-12 days) and rotiferan (2.5 days) zooplankton. For Lake Tineo, residence time during inundation (7 days) is longer than generation times for all taxa except copepods. Although Lake Aguilera receives water from Lake Tineo during inundation, zooplankton densities were greatly reduced during passage through a large bed of the floating aquatic grass Paspalum repens located near the outlet of Lake Tineo. This orientation was not size-selective and affected phytoplankton as well as zooplankton. In the Orinoco floodplain zooplankton densities are affected not only by hydraulic residence times but also by passage of water between lakes, which exposes populations to large losses within macrophyte beds. Retention of plankton by floating macrophyte beds is potentially important to the trophic ecology of tropical floodplain lakes because it results in the concentration of planktonic production in epiphytic and benthic habitats, where it can readily support food webs consisting of macroinvertebrates and fishes. Export of plankton from floodplain waterbodies to the river is also reduced by this mechanism. (Author's abstract)
W90-08012

SIZE-ABUNDANCE DISTRIBUTION AND TAXONOMIC COMPOSITION OF PLANKTON IN AN OLIGOTROPHIC, HIGH MOUNTAIN LAKE (LA CALDERA, SIERRA NEVADA, SPAIN).
Malaga Univ. (Spain). Dept. de Ecologia. F. Echevarria, P. Carrillo, F. Jimenez, P. Sanchez-Castillo, and L. Cruz-Pizarro. Journal of Plankton Research JPLRD9, Vol. 12, No. 2, p 415-422, March 1990. 4 fig, 30 ref. Junta de Andalucia (Project no. 9/88) and CICYT Project no. PPA86-0401.

Descriptors: *Limnology, *Mountain lakes, *Oligotrophic lakes, *Plankton, *Spain, Biomass, Chrysophyta, Copepods, Cyanophyta, Daphnia, Diatoms, Energy transfer, Phytoplankton, Population density, Species composition, Trophic level, Zooplankton.

This paper describes the main features of the size-abundance distribution and taxonomic structure of plankton in an oligotrophic, high mountain lake (La Caldera, Sierra Nevada, Spain). The distribution is characterized by a discontinuity in the size range between 2000 and 32,000 cu microns (cell volume). Phytoplankton are numerically dominated by the cyanobacterium Cyanarcus sp. followed by the chrysophyte Chromulina nevadensis and the diatom Cyclotella ocellata. Some microplanktonic species such as the diatom Navicula radiosa were observed sporadically. The size spectrum and composition of the zooplankton community are dominated by the copepod Mixodiaptomus luciniatus. On considering biomass, however, the maximum values are associated with the largest size classes, dominated by the cladoceran Daphnia pulex. Both the size structure and taxonomic composition of the planktonic community studied are consistent with expectations based on theories relating the pattern of energy flow and trophic status in lakes. (Author's abstract)
W90-08013

HYPERSCUMS AND THE POPULATION DYNAMICS OF MICROCYSTIS AERUGINOSA.
Kinneret Limnological Lab., Tiberias (Israel). T. Zohary, and R. D. Robarts. Journal of Plankton Research JPLRD9, Vol. 12, No. 2, p 423-432, March 1990. 3 fig, 18 ref.

Descriptors: *Limnology, *Microcystis, *Population dynamics, *Reservoirs, *Scum, Cyanophyta, Hartbeespoort Dam, Hyperscum, Lakes, Phytoplankton, Seasonal variation, Simulation, South Africa, Wind velocity.

Conceptual models, based on 7 years of data, are constructed to simulate the annual cycle and population dynamics of Microcystis aeruginosa in hypertrophic, warm monomictic Hartbeespoort Dam, South Africa in order to assess the role of hyperscum formation. In Hartbeespoort Dam the large summer planktonic population (mean epilimnion biovolumes of 20-50 cu mm/L) and the low wind speed resulted in the formation of hyperscums (thick, crusted accumulations of floating cyanobacteria at wind-protected sites) containing up to 50% of the total standing crop for 2-3 months in 4 out of 5 years. In years in which hyperscums formed the post-maximal summer population maintained itself throughout autumn and into late winter before declining to the annual nadir (>1000 cells/L). When hyperscums did not form, or were artificially removed, the population fell to similarly low levels as early as May (autumn) and remained small until the spring growth phase began. Microcystis cells decompose in the upper layers of a hyperscum, but this is not a major loss to the planktonic population. Hyperscums are refuges which help maintain large planktonic standing crops during winter when growth is not possible but have no effect on the long-term (perennial) survival of Microcystis. (Author's abstract)
W90-08014

TROPHIC STATUS AND THE PELAGIC SYSTEM IN LAGO MAGGIORE.
Istituto Italiano di Idrobiologia, Pallanza (Italy). For primary bibliographic entry see Field 5C.
W90-08065

SPRING DEVELOPMENT OF PHYTOPLANKTON IN LAKE ERKEN: SPECIES COMPOSITION, BIOMASS, PRIMARY PRODUCTION AND NUTRIENT CONDITIONS: A REVIEW.
Uppsala Univ. (Sweden). Limnologiska Institutionen. K. Pettersson. Hydrobiologia HYDRB8, Vol. 191, p 9-14, February 28, 1990. 4 fig, 16 ref.

Descriptors: *Limnology, *Phytoplankton, *Sweden, Biomass, Dinoflagellates, Lake Erken, Phosphorus, Primary productivity, Seasonal distribution, Stephanodiscus.

In Lake Erken (Sweden), climatic factors such as duration of ice cover, snow depth, and insolation govern the phytoplankton development and the species composition during the spring, with significant variations from year to year. Generally, the small diatom Stephanodiscus hantzschii var. pusillus creates a conspicuous peak at ice-break. In some years motile dinoflagellates start to develop under the ice in early March, thus resulting in a much longer spring bloom. The highest biomasses were recorded in 1954-1955 with values up to 11 mg/L of fresh weight. The chlorophyll a concentrations have at most reached an epilimnetic average of 30 microgram/L. The primary production reached a maximum of 2200 mg C per sq m/day in 1955 and the average production for two months during the spring varied from 30-64 mg C cu m/day. Phosphorus was the limiting nutrient at the end of the spring bloom. This was confirmed by orthophosphate concentrations, algal surplus P content, and alkaline phosphatase activity, as well as estimates of inorganic N:P and C:P ratios and nutrient enrichment experiments. (Author's abstract)
W90-08066

SOME CHARACTERISTICS OF THE COMMUNITY OF AUTOTROPHS OF LAKE SEVAN IN CONNECTION WITH ITS EUTROPHICATION.
Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station. For primary bibliographic entry see Field 5C.
W90-08067

ASPECTS OF THE ECOLOGY OF A FILAMENTOUS ALGA IN A EUTROPHIED LAKE.
Warsaw Univ. (Poland). Dept. of Hydrobiology. For primary bibliographic entry see Field 5C.

W90-08068

RELATION OF BIOTIC AND ABIOTIC INTER-ACTIONS TO EUTROPHICATION IN TJEU-KEMEER, THE NETHERLANDS.
Limnologisch Inst., Oosterzee (Netherlands).
For primary bibliographic entry see Field 5C.
W90-08069

ZOOPLANKTON COMMUNITY CHANGES IN LAKE KINNERET (ISRAEL) DURING 1969-1985.
Kinneret Limnological Lab., Tiberias (Israel).
M. Gophen, S. Serruya, and P. Spataru.
Hydrobiologia HYDRB8, Vol. 191, p 39-46, February 28, 1990. 2 fig, 8 tab, 46 ref.

Descriptors: *Israel, *Lake Kinneret, *Limnology, *Zooplankton, Animal behavior, Crustacea, Fish food organisms, Life history studies, Population dynamics, Predation.

Long-term records (1969-1985) of zooplankton density in Lake Kinneret (Israel) indicated significant reduction of biomass (Copepoda, Cladocera, and Rotifera) and production (Copepoda and Cladocera). Nauplius and adult copepod densities decreased but those of copepodites did not change. Meoscyclops was suppressed more than the smaller Thermocyclops and males of both genera became more abundant relative to the larger females. Ratios of 'small/large' Cladocera densities became higher. Numbers of total cladocerans were stable and therefore reduction in Cladocera grazing capacity is assumed. The abundant Keratella spp. were reduced. It is likely that intensification of fish visual-attack-predation pressure shifted the size-class structure towards smaller adult copepods and cladocerans. Reduction of Keratella spp. and copepod nauplii probably was affected by increasing pressure of fish filter-feeders. Data on fish food consumption, feeding behavior, and fisheries management suggested their direct impact on long-term changes of zooplankton in Lake Kinneret. (Author's abstract)
W90-08070

CONTRIBUTION OF SILVER CARP (HY-POPHTALMICHTHYS MOLITRIX) TO THE BIOLOGICAL CONTROL OF NETOFA RESER-VOIRS.
Nessin Water Quality Central Lab., Nazareth (Israel).
H. Leventer, and B. Teltsch.
Hydrobiologia HYDRB8, Vol. 191, p 47-55, February 28, 1990. 5 fig, 4 tab, 18 ref.

Descriptors: *Biological control, *Israel, *Netofa reservoirs, *Water quality control, Carp, Ecosystems, Phytoplankton, Zooplankton.

When silver carp were introduced into the Netofa reservoirs (Israel) at an initial density of 300-4500 fish/ha to control phytoplankton and zooplankton, there was a significant reduction of algae, zooplankton, and suspended organic matter. Annual yield ranged from 600 to 1500 kg/ha. The growth of individual fish after 6-8 yr was 6-15 kg/fish. Introducing silver carp to reservoirs for biological control creates a balanced ecological system in which interspecific competition is minimal and the environmental improvements are considerable. Silver carp and bottom-feeding fish filter phytoplankton and zooplankton from the water; their excrement enriches increases the organic matter on the bottom that is suitable for zoobenthos. (Author's abstract)
W90-08071

CHANGES IN THE FISH AND ZOOPLANK-TON COMMUNITIES OF RINGSJON, A SWEDISH LAKE UNDERGOING MAN-MADE EUTROPHICATION.
Institute of Freshwater Research, Drottningholm (Sweden).
For primary bibliographic entry see Field 5C.
W90-08072

PHOSPHORUS DYNAMICS FOLLOWING RESTORATION MEASURES IN THE LOOS-DRECHT LAKES (THE NETHERLANDS).
Limnologisch Inst., Nieuwersluis (Netherlands).
For primary bibliographic entry see Field 5G.
W90-08074

SEASONAL VARIABILITY OF N:P RATIOS IN EUTROPHIC LAKES.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 5B.
W90-08075

TROPHIC RESPONSE TO PHOSPHORUS IN ACIDIC AND NON-ACIDIC LAKES IN NOVA SCOTIA, CANADA.
Canadian Wildlife Service, Halifax (Nova Scotia).
J. J. Kerekes, A. C. Blouin, and S. T. Beauchamp.
Hydrobiologia HYDRB8, Vol. 191, p 105-110, February 28, 1990. 5 fig, 1 tab, 22 ref.

Descriptors: *Acid rain effects, *Eutrophic lakes, *Limnology, *Nova Scotia, *Oligotrophic lakes, *Phosphorus, *Trophic level, Aquatic insects, Benthos, Comparison studies, Hydrogen ion concentration, Nutrients.

Twenty lakes (oligotrophic or eutrophic) with a wide range of acidity (pH 3.5 to 7.6) showed a typical response to total P with respect to algal biomass (OECD relationship), irrespective of their acidity. Zooplankton abundance is related to total P, except for an outlier lake which is very acidic and eutrophic. This lake, however, has abundant benthic and pelagic insect fauna and shows an overall 'normal' trophic response to phosphorus. In three lakes where planktonic primary production at light optimum (Pmax) was measured, it was highest in the most acidic lake (pH 4.4), which has the largest total P concentration. (Author's abstract)
W90-08076

TROPHIC INTERACTIONS AMONG HETERO-TROPHIC MICROPLANKTON, NANOPLANK-TON, AND BACTERIA IN LAKE CONSTANCE.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
T. Weisse.
Hydrobiologia HYDRB8, Vol. 191, p 111-122, February 28, 1990. 10 fig, 50 ref.

Descriptors: *Energy transfer, *Food chains, *Lake Constance, *Limnology, *West Germany, Bacteria, Ecosystems, Plankton, Predation, Seasonal variation, Trophic dynamics.

A considerable part of the pelagic energy flow in Lake Constance (Federal Republic of Germany) is channelled through a highly dynamic microbial food web. In-situ experiments using the lake water dilution technique of Landry and Hasset revealed that grazing by heterotrophic nanoflagellates (HNF) smaller than 10 micron is the major loss factor of bacterial production. An average flagellate ingests 10-100 bacteria per hour. Nano-ciliates and micro-ciliates have been identified as the main predators of HNF. If no other food is used, between 3 and 40 HNF are composed per ciliate per hour. Other protozoans and small metazoans such as rotifers are of minor importance in controlling HNF population dynamics. Clearance rates varied between 0.2 and 122.8 nanoliter HNF/hr and between 0.2 and 53.6 microliter ciliates/hr, respectively. Ingestion and clearance rates measured for HNF and ciliates are in good agreement with result obtained by other investigators from different aquatic environments and from laboratory cultures. Both the abundance of all three major microheterotrophic categories (bacteria, HNF, and ciliates), and the grazing pressure within the microbial loop show pronounced seasonal variations. (Author's abstract)
W90-08077

INFLUENCE ON PHYTOPLANKTON BIO-MASS IN LAKES OF DIFFERENT TROPHY BY PHOSPHORUS IN LAKE WATER AND ITS REGENERATION BY ZOOPLANKTON.

Polish Academy of Sciences, Mikolajki. Hydrobiological Research Station.
For primary bibliographic entry see Field 5C.
W90-08078

ALGAL GROWTH AND LOSS RATES OF LAKE LOOSDRECHT: FIRST EVALUATION OF THE ROLES OF LIGHT AND WIND ON A BASIS OF STEADY STATE KINETICS.
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
H. J. Gons, and M. Rijkeboer.
Hydrobiologia HYDRB8, Vol. 191, p 129-138, February 28, 1990. 4 fig, 1 tab, 25 ref.

Descriptors: *Eutrophic lakes, *Lake Loosdrecht, *Limnology, *Model studies, *Primary productivity, *The Netherlands, Algae, Chlorophyll a, Growth kinetics, Light, Phytoplankton, Wind.

Lake Loosdrecht (The Netherlands) is shallow, highly eutrophic, and subject to frequent wind-induced resuspension of settled algae and detritus. The summer phytoplankton consists of filamentous prokaryotes. Chlorophyll a levels are stable over the summer at a concentration of about 160 mg/cu m; losses due to grazing and sinking are small. Epipelic chlorophyll a concentrations range from 0 to 250, but about 50 mg/sq m is typical. In situ rates of change in chlorophyll a in the water column were related to specific growth rates predicted by a model of light-limited growth. In the model, incident light is partitioned among algae, tripton, and background color, to determine the light available for algal growth and cell maintenance. Model coefficients are derived primarily from laboratory studies of the growth of Prochlorothrix hollandica, an abundant species in the lake in summer. Assuming constant rates of loss due to grazing and sinking, for summers of 1985 and 1986 some 56% of the variation in the chlorophyll a in the lake water was explained by change in light conditions alone and 77% by light and wind-driven resuspension of epipelic chlorophyll a together. These factors had little influence on the phytoplankton biomass in 1983 and 1984; other environmental conditions, e.g., phosphorus availability, may have been important. Also, the laboratory-derived growth kinetics of P. hollandica may not have been equally suitable for modeling in the four summers. (Author's abstract)
W90-08079

INTERACTIONS BETWEEN SEDIMENT AND WATER IN A SHALLOW AND HYPERTROPH-IC LAKE: A STUDY ON PHYTOPLANKTON COLLAPSES IN LAKE SOBYGARD, DEN-MARK.
National Environmental Research Inst., Silkeborg (Denmark).
M. Sondergaard, E. Jeppesen, P. Kristensen, and O. Sortkjaer.
Hydrobiologia HYDRB8, Vol. 191, p 139-148, February 28, 1990. 3 fig, 2 tab, 15 ref.

Descriptors: *Cycling nutrients, *Denmark, *Limnology, *Phytoplankton, *Population dynamics, Dissolved oxygen, Ecosystems, Hypertrophic lakes, Lake Sobygard, Lake sediments, Nitrogen, Phosphorus, Shallow water, Zooplankton.

Short-term changes in phytoplankton and zooplankton biomass have occurred 1-3 times every summer for the past 5 yr in the shallow and hypertrophic Lake Sobygard, Denmark. During the collapse of the phytoplankton biomass in 1985, lasting about 2 wk, the lake water became almost anoxic, followed by rapid increases in N and P at rates of 100-400 mg N/sq m/day and 100-200 mg P/sq m/day. Average external loading during this period was about 350 mg N/sq m/day and 5 mg P/sq m/day. Due to high phytoplankton biomass and subsequent high sedimentation and recycling of nutrients, gross release rates of P and N were several times higher than net release rates. The net summer sediment release of P was usually about 40 gm P/sq m/day, corresponding to a 2-fold to 3-fold increase in the net P release during the collapse. The N and P increase during the collapse is attributed mainly to a decreased sedimentation be-

cause of low algal biomass. The nutrient interactions between sediment and lake water during phytoplankton collapse, therefore, were changed from being dominated by both a large input and a large sedimentation of nutrients to a dominance of only a large input. N was derived from both the inlet and the sediment, whereas, P was preferentially derived from the sediment. Different temperature levels may be a main reason for the different release rates from year to year. (See also W90-08081) (Author's abstract)
W90-08080

INTERACTIONS BETWEEN PHYTOPLANKTON, ZOOPLANKTON, AND FISH IN A SHALLOW, HYPERTROPHIC LAKE: A STUDY OF PHYTOPLANKTON COLLAPSES IN LAKE SOBYGARD, DENMARK.
National Environmental Research Inst., Silkeborg (Denmark).
E. Jeppesen, M. Sondergaard, O. Sorkjaer, E. Mortensen, and P. Kristensen.
Hydrobiologia HYDRB8, Vol. 191, p 149-164, February 28, 1990. 7 fig, 1 tab, 49 ref.

Descriptors: *Denmark, *Eutrophic lakes, *Lake Sobygard, *Limnology, *Phosphorus, *Population dynamics, Dissolved oxygen, Ecosystems, Fish, Food chains, Hydrogen ion concentration, Hypertrophic lakes, Nitrogen, Shallow water, Zooplankton.

Lake Sobygard, Denmark is recovering after a 10-fold decrease in external P loading in 1982. In July 1985, for example, chlorophyll a dropped from 650 microgram/L to about 12 microgram/L with 3-5 days. Simultaneously, oxygen concentration dropped from 20-25 mg O2/L to less than 1 mg O2/L, and pH decreased from 10.7 to 8.9. Less than 10 days later, the phytoplankton biomass had recovered fully. During all such phytoplankton collapses, the density of filter-feeding zooplankton increased markedly, and a clear-water period ensued. Due to marked changes in age structure of the fish stock, different zooplankton species were responsible for the density increase in different years, and consequently different collapse patterns and frequencies were observed. The sudden increase in density of filter-feeding zooplankton from a generally low summer level to extremely high levels during algal collapses, could be explained neither by changes in regulation from below (food) nor from above (predation). The density increase was found after a period with high N/P ratios in phytoplankton or nitrate depletion in the lake. During that period phytoplankton biomass, primary production, and thus pH decreased, the latter from 10.8-11.0 to 10.5. It is hypothesized that direct or indirect effects of high pH are important in controlling the filter-feeding zooplankton of this hypertrophic lake. Secondarily, the pH affects the trophic interactions in the lake water and the net internal loading of nutrients. Consequently, not only a high content of planktivorous fish, but high pH, may promote uncoupling of the grazing food-web in highly eutrophic shallow lakes, thereby enhancing eutrophication. (See also W90-08080) (Author's abstract)
W90-08081

PHYTOPLANKTON AND ZOOPLANKTON (CLADOCERA, COPEPODA) RELATIONSHIP IN THE EUTROPHICATED RIVER DANUBE (DANUBIALIA HUNGARICA, CXI).
Magyar Tudomanyos Akademia, Budapest. Station for Danube Research.
For primary bibliographic entry see Field 5C.
W90-08082

ZOOPLANKTON STRUCTURE IN THE LOOSDRECHT LAKES IN RELATION TO TROPHIC STATUS AND RECENT RESTORATION MEASURES.
Limnologisch Inst., Nieuwersluis (Netherlands).
For primary bibliographic entry see Field 5G.
W90-08083

ECOLOGICAL BACKGROUND AND IMPORTANCE OF THE CHANGE OF CHIRONOMID

FAUNA (DIPTERA: CHIRONOMIDAE) IN SHALLOW LAKE BALATON.
Lajos Kossuth Univ., Debrecen (Hungary). Dept. of Ecology.
G. Devai.
Hydrobiologia HYDRB8, Vol. 191, p 189-198, February 28, 1990. 6 fig, 26 ref.

Descriptors: *Eutrophication, *Hungary, *Lake Balaton, *Limnology, *Midges, Lake sediments, Long-term studies, Nutrients, Population dynamics, Self-purification, Shallow water, Spatial distribution, Temporal distribution, Water quality.

Changes were recorded in the composition of the open-water, bottom-dwelling chironomid fauna in Lake Balaton between 1978-1984 with the aim of examining the causes of these changes and to discover their significance for the ecology of the lake. The spatio-temporal dispersion of larvae was compared with the water and sediment quality of each basin of the lake. Under present conditions, it is clear that nutrient status is the chief environmental factor. Studies of population dynamics show that chironomids play a highly important role in preserving sediment quality. Chironomids are an essential element in the organic matter circulation of the lake. They dominate a sub-system that retards water quality degradation, and thus play a prominent role in the natural prevention of eutrophication. (Author's abstract)
W90-08084

TROPHIC RELATIONSHIPS IN THE PELAGIC ZONE OF MONDSEE, AUSTRIA.
Institut fuer Limnologie, Mondsee (Austria).
M. Dokulil, A. Herzig, and A. Jagsch.
Hydrobiologia HYDRB8, Vol. 191, p 199-212, February 28, 1990. 11 fig, 48 ref.

Descriptors: *Austria, *Limnology, *Mountain lakes, *Trophic level, Biomass, Ecosystems, Fish, Foods, Pelagic zone, Phosphorus, Phytoplankton, Population dynamics, Seasonal variation, Silicates, Temperature, Zooplankton.

Data are presented on nutrient concentrations, phytoplankton biovolume development, zooplankton composition and population dynamics, and fish from a deep, stratifying, alpine lake (Mondsee, Austria) during a 3-yr period between 1982 and 1984. Development of the phytoplankton is related closely to structuring events of the physico-chemical environment. Dissolved silicate and P concentrations are critical in the summer. During summer algal abundance is affected largely by grazing of zooplankton, but no clear-water phase was observed at the end of the spring peak of phytoplankton. Temperature and food are factors responsible for the timing and growth of the zooplankton populations. Because of close overlap in the Epilimnion, exploitative and mechanical interference competition and predation by invertebrate and vertebrate predators are the main structuring forces acting on the zooplankton community, and hence influence phytoplankton indirectly. (Author's abstract)
W90-08085

TROPHIC RELATIONSHIPS BETWEEN PRIMARY PRODUCERS AND FISH YIELDS IN LAKE BALATON.
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
P. Biro, and L. Voros.
Hydrobiologia HYDRB8, Vol. 191, p 213-221, February 28, 1990. 7 fig, 2 tab, 24 ref. Akademiai Kutatasi Alap Theme 30054.

Descriptors: *Fish, *Hungary, *Lake Balaton, *Limnology, *Primary productivity, *Trophic level, Bream, Chlorophyll a, Energy conversion, Fisheries, Statistics.

Relationships between chlorophyll a content of the water, the shoreline length:water area ratio, and the annual total fish yield (catch per unit effort, CUE, in kg/ha/100 hr as annual mean values) were calculated by multivariable regression for Lake Balaton (Hungary). The determination coefficient (r-squared = 0.913) showed a significant

dependence of fish yield on morphometry of the different lake areas. Accordingly, fish carrying capacity of the open water areas, calculated from chlorophyll a content and surface areas, ranged from 12-34%, but that of the littoral zone ranged from 66-88%. These findings were supported by echo-sounding records of the horizontal distribution of fish. Bream (Abramis brama L.) contributes 70-80% of the fish stock and yield. It food consists mainly of zooplankton and benthic invertebrates in ratios that vary widely with season and depended on the age of fish. Average daily food consumption of individuals (age group 3+ and over) varies between 2 and 5 g. Bream consume two-times to three-times more food in the southwest basin than in the northeast one. This means that stocks presently inhabiting areas from NE to SW consume annually 13,249-20,085 t/yr of food. According to estimated caloric values, the annual energy consumption of local populations along the longitudinal axis of the lake varies for 93 to 141 kJ/sq m/yr. The efficiency of energy transfer from primary producers to fish is low and varies from 0.04 to 0.1%. (Author's abstract)
W90-08086

PREDATION PRESSURE FROM ABOVE: OBSERVATIONS ON THE ACTIVITIES OF PISCIVOROUS BIRDS AT A SHALLOW EUTROPHIC LAKE.
Ulster Univ., Coleraine (Northern Ireland). Limnology Lab.
I. J. Winfield.
Hydrobiologia HYDRB8, Vol. 191, p 223-231, February 28, 1990. 4 fig, 27 ref.

Descriptors: *Fish, *Predation, *Sweden, *Water birds, Animal behavior, Comparison studies, Estimating, Eutrophic lakes, Lake Sovdeborgssjon, Mathematical analysis, Seasonal distribution, Shallow water.

The foraging activities of piscivorous birds at Sovdeborgssjon, a small eutrophic lake in southern Sweden, were observed during the ice-free months of 1984. Species-specific patterns of abundance and distribution were apparent. Great crested grebes and red-breasted mergansers were present for periods of months and weeks, respectively, whereas grey herons, black-headed gulls, and red kites made numerous shorter visits. Both cyprinids and percids were seen to be captured. Speculative calculations suggest that the amount of fish removed by birds is significant when compared with that taken by the lake's piscivorous fish, constituting 34% of total consumption in summer and at 99% becoming by far the more important component in late autumn. Several fundamental differences were noted between bird predators and fish predators of fish. These included the increased metabolic demands of birds as they relate to consumption rates, the greater mobility of the birds, and the ability of birds to pursue fish in multiple habitat types. (Author's abstract)
W90-08087

LIGHT-LIMITED ALGAL GROWTH IN LAKE LOOSDRECHT: STEADY STATE STUDIES IN LABORATORY SCALE ENCLOSURES.
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
M. Rijkeboer, and H. J. Gons.
Hydrobiologia HYDRB8, Vol. 191, p 241-248, February 28, 1990. 3 fig, 3 tab, 23 ref.

Descriptors: *Algal growth, *Eutrophic lakes, *Lake Loosdrecht, *Light limitation, *Limnology, *Model studies, *The Netherlands, Biomass, Chlorophyll, Color, Energy conversion, Phytoplankton, Seston, Tripton.

Phytoplankton growth in the shallow, turbid Lake Loosdrecht (The Netherlands) is influenced significantly by light availability and thus the concentrations of light-attenuating materials. The system is highly eutrophic and supports an algal biomass of about 160 mg chlorophyll (Chl) per cubic m. A model is proposed that predicts algal growth in the lake as a function of the light received and subsequent attenuation in the water column by phyto-

plankton, tripton, and background color. The model is based on an energy balance that relates growth rate to the 'true' growth yield on light energy and energy demand for cell maintenance. The coefficients for energy conversion and cell maintenance were determined from steady-state growth kinetics of Prochlorothrix hollandica in light-limited laboratory flow systems with the same depth as the lake and receiving summer average conditions of irradiance. Light attenuation by phytoplankton and tripton were quantified using specific attenuation coefficients (0.11 sq m/mg Chl for phytoplankton and 0.23 sq m/mg dry weight for tripton. The growth studies demonstrated that Lake Loosdrecht can support a much higher algal biomass in the absence of non-algal particulate matter. The proposed model was used to predict chlorophyll a concentrations as they depend on growth rate and levels of tripton. Since approximately 75% of the sestonic dry weight in Lake Loosdrecht may be attributed to tripton, it is concluded that the algal biomass is lowered markedly by the abundance of tripton in the water column. (Author's abstract)
W90-08088

STIR-UP EFFECT OF WIND ON A MORE-OR-LESS STRATIFIED SHALLOW LAKE PHYTO-PLANKTON COMMUNITY, LAKE BALATON, HUNGARY.
Hungarian Natural History Museum, Budapest. Botanical Dept.
J. Padisak, L. G.-Toth, and M. Rajczy.
Hydrobiologia HYDRB8, Vol. 191, p 249-254, February 28, 1990. 5 fig, 29 ref.

Descriptors: *Hungary, *Lake Balaton, *Limnology, *Phytoplankton, *Wind, Circadian rhythm, Cluster analysis, Community structure, Destratification, Flagellates, Shallow water, Squalls, Storms, Water circulation.

Microstratification of phytoplankton in the large, shallow Lake Balaton, Hungary, was studied during a 24-hr period. Dissolved O2 showed biological stratification: flagellates exhibited a definite circadian rhythm. In the middle of the investigation there was a heavy storm, which was followed by the disappearance of differences between different layers of water. Storm-induced destratification was examined by cluster analysis. Abundances of dominant species changed differently in connection with the storm. Numbers of Nitzschia sp. increased due to stirring up of the sediment surface. Numbers of single-celled or colony-forming species (Cyclotella comta, Crucigenia quadrata, Coelosphaerium kuetzingianum) practically did not change. Numbers of all the three dominant filamentous species Aphanizomenon flos-aquae f. klebahnii, Lyngbya limnetica, Planctonema lauterbornii) significantly decreased, which might be attributed to an unknown loss process, followed by a competitive displacement by algae of small cell size. (Author's abstract)
W90-08089

ASSESSMENT OF THE IMPORTANCE OF EMERGENT AND FLOATING-LEAVED MACROPHYTES TO TROPHIC STATUS IN THE LOOSDRECHT LAKES (THE NETHERLANDS).
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
T. Malthus, E. P. H. Best, and A. G. Dekker.
Hydrobiologia HYDRB8, Vol. 191, p 257-263, February 28, 1990. 1 fig, 4 tab, 27 ref.

Descriptors: *Aquatic plants, *Limnology, *Loosdrecht Lakes, *Macrophytes, *The Netherlands, *Trophic level, Aerial photography, Biomass, Carbon, Cycling nutrients, Degradation, Lake restoration, Nitrogen, Phosphorus, Tissue analysis.

The potential importance of six major emergent and floating-leaved macrophyte species in recycling of sedimentary phosphorus in the Loosdrecht Lakes (The Netherlands) was studied. Representative plant samples were collected at the time of maximum biomass and analyzed for biomass and C, N, and P content. Species cover was determined by aerial photography. Total cover in the seven

lakes studied ranged from 2-26%. For the four main species, biomass per unit area increased with lake trophic status. Consistent differences in C, N, and P contents per unit biomass were not observed. Although cover values were small, significant amounts of C, N, and P were contained in the macrophytes when compared with maximum sestonic content. Potential P loads from macrophyte decay were calculated. In Lake Loosdrecht, the P load represented 15% of current external P inputs. The potential importance of macrophyte decay in P recycling in the other lakes is greater. Decay of macrophyte species at the end of the growing season appears to affect autumnal nutrient and chlorophyll a levels in the water column of some lakes. The re-establishment of submerged species following lake restoration may increase the importance of this pathway in the lakes. (Author's abstract)
W90-08090

QUALITATIVE AND QUANTITATIVE RELATIONSHIPS OF AMPHIPODA (CRUSTACEA) LIVING ON MACROPHYTES IN LAKE BALATON (HUNGARY).
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
I. B. Musko.
Hydrobiologia HYDRB8, Vol. 191, p 269-274, February 28, 1990. 5 fig, 2 tab, 14 ref.

Descriptors: *Crustaceans, *Ecosystems, *Hungary, *Lake Balaton, *Limnology, Biomass, Community development, Hypertrophic lakes, Macrophytes, Population dynamics, Reproduction, Spatial distribution, Species composition, Trophic level.

Species composition, eggs/female, and the size-frequency of Amphipoda living on dominant submerged macrophytes (Potamageton perfoliatus and Myriophyllum spicatum) were analyzed at 10 sampling stations on the northern and southern shoreline of Lake Balaton (Hungary). The dominant amphipod at each sampling station was Corophium curvispinum (85.9%-99.8%, mean: 96.6%). Dikerogammarus haemobaphes and D. villosus also were found. The number of amphipod individuals per g macrophyte dry weight ranged from 5 to 574; the lowest value was found near Keszthely, the highest near B. Maria. The developmental stages of the C. curvispinum population differed in different parts of Lake Balaton. The mean number of eggs of C. curvispinum ranged from 2.4-6.3, showing differences at the different sampling station. The mean number of eggs per egg-bearing female of D. haemobaphes was 11.7; for D. villosus it was 19.1. The total biomass of amphipods (in mg animal dry weight/g macrophyte dry weight) ranged from 1.2 to 59.8. The lowest value was observed near Keszthely (the most hypertrophic basin in Lake Balaton), whereas the highest value was seen near B. Maria. (Author's abstract)
W90-08091

IMPACT OF CYPRINIDS ON ZOOPLANKTON AND ALGAE IN TEN DRAINABLE PONDS.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
M. L. Meijer, E. H. R. R. Lammens, A. J. P. Raat, M. P. Grimm, and S. H. Hosper.
Hydrobiologia HYDRB8, Vol. 191, p 275-284, February 28, 1990. 6 fig, 2 tab, 27 ref.

Descriptors: *Fish, *Ponds, *Predation, Algae, Artificial lakes, Community structure, Ecosystems, Experimental studies, Zooplankton.

The impact of cyprinids on algae, zooplankton, and physical and chemical water quality was examined in 10 drainable ponds (0.1 ha, 1.3 m depth) by dividing each pond into two equal parts. One half of each pond was stocked with 0+ cyprinids (bream, carp, and roach of 10-15 mm), the other was free of fish. The average biomass of 0+ fish at draining of the ponds was 466 kg/ha, to which carp contributed about 80%. The fish and non-fish compartments showed significant differences. In the non-fish compartments, the density of Daphnia hyalina was 10-30 individuals/L and that of Daphnia magna 2-4 individuals/L, whereas in the fish

compartments densities were about 1 individual/L. Cyclopoid copepods and Bosmina longirostris, however, showed higher densities in the fish compartments. The composition of algae in the two compartments differed only slightly, but the densities were lower in the non-fish compartments. The significant difference in turbidity probably was caused by resuspension of sediment by carp. No significant difference in nutrient concentration between the compartments was found. (Author's abstract)
W90-08092

RESTORATION BY BIOMANIPULATION IN A SMALL HYPERTROPHIC LAKE: FIRST-YEAR RESULTS.
Water Board of Utrecht (Netherlands).
For primary bibliographic entry see Field 5G.
W90-08093

OPERATION OF THE KIS-BALATON RESERVOIR: EVALUATION OF NUTRIENT REMOVAL RATES.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 5G.
W90-08094

ENCLOSURES STUDY OF TROPHIC LEVEL INTERACTIONS IN THE MESOTROPHIC PART OF LAKE BALATON.
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
I. Tatrai, L. G.-Toth, V. Istvanovics, and J. Zlinszky.
Hydrobiologia HYDRB8, Vol. 191, p 307-313, February 28, 1990. 5 fig, 1 tab, 11 ref.

Descriptors: *Ecosystems, *Hungary, *Lake Balaton, *Limnology, *Trophic level, Algae, Bream, Chlorophyll a, Cyanophyta, Cycling nutrients, Diatoms, Enclosures, Lake sediments, Phytoplankton, Suspended solids, Transparency.

Enclosures, open to the bottom sediments and the atmosphere, containing about 17 cu m of lake water in the mesotrophic area of Lake Balaton (Hungary), were used to elucidate the role of the benthivorous fish bream (Abramis brama L.) during 1984-1986. Throughout the study period, the water was less transparent in the enclosure containing fish, which strongly influenced the concentrations of suspended solids and chlorophyll a. Both phytoplankton biomass and production responded readily to nutrient increase in the enclosure with fish. In 1985 diatoms were replaced by cyanobacteria, whereas in 1986, at a lower fish stocking, a shift in algal structure towards chlorophytes was observed. Egested organic substances and the resuspension of sediment particles by fish increased bacterial production. (Author's abstract)
W90-08095

SURFACE WATER ACIDIFICATION PROJECT (SWAP) PALEOLIMNOLOGY PROGRAMME.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 5C.
W90-08096

RADIOMETRIC DATING OF THE UNITED KINGDOM SWAP SITES.
Liverpool Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
For primary bibliographic entry see Field 5C.
W90-08097

LEAD-210 CHRONOLOGY OF THE SCANDINAVIAN SWAP SITES.
Uppsala Univ. (Sweden). Dept. of Physics.
For primary bibliographic entry see Field 5C.
W90-08098

DIATOM COMMUNITIES--THEIR RESPONSE TO CHANGES IN ACIDITY.

Bristol Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 5C.
W90-08099

ECOPHYSIOLOGY OF EPILITHIC DIATOM COMMUNITIES OF ACID LAKES IN GALLOWAY, SOUTHWEST SCOTLAND.
Hatfield Polytechnic (England). Div. of Environmental and Earth Sciences.
M. A. Smith.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 251-256, March 12, 1990. 5 fig, 1 tab, 24 ref.

Descriptors: *Acid lakes, *Acid rain, *Diatoms, *Limnology, *Physiological ecology, *Scotland, Aluminum, Calcium, Chlorophyll, Enzymes, Hydrogen ion concentration, Limiting nutrients, Nitrates, Oligotrophic lakes, Phosphates, Silicates, Species composition.

Lake-water chemistry in Galloway, southwest Scotland is characterized by strong correlations between low calcium and high aluminum concentrations and low hydrogen ion concentrations. Nitrate and silicate levels were sufficient for diatom growth but phosphate was limiting. Nitrogen:phosphorus and silicon:phosphorus ratios indicated severe phosphate limitation according to the Redfield ratio. Chlorophyll-a specific epilithic phosphatase activity expressed as a ratio of acid to alkaline phosphatase activity showed a clear relation to hydrogen ion concentration with acid phosphatase predominating at hydrogen ion concentrations of 5.5 and below. Acid phosphatase activity in epilithon from low hydrogen ion concentration was inducible as phosphate levels decreased, and inhibited by the addition of phosphate. Inducible acid phosphatase activity clearly confers a selective advantage to epilithic diatom communities growing in oligotrophic lakes of low hydrogen ion concentrations. (Author's abstract)
W90-08100

DIATOM QUALITY CONTROL AND DATA HANDLING.
University Coll., London (England). Palaeoecology Research Unit.
M. A. R. Munro, A. M. Kreiser, R. W. Battarbee, S. Juggins, and A. C. Stevenson.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 257-261, March 12, 1990. 2 fig, 4 ref.

Descriptors: *Acid rain, *Data collections, *Data storage and retrieval, *Diatoms, *Limnology, *Quality control, Hydrogen ion concentration, Laboratory methods, Paleolimnology, Surface Water Acidification Project Taxonomy, Water quality standards, Water quality trends.

The diatom section of the Surface Water Acidification Project (SWAP) Paleolimnology Programme brought together data from many sources. One of the aims of the project was to construct a single large hydrogen ion concentrations calibration dataset, by combining modern lake hydrogen ion concentration values with modern surface-sediment diatom assemblages and to use the calibration to reconstruct past lake hydrogen ion concentrations from the assemblages in sediment cores. However, reconstructions based on small regional subsets of chemical and diatom data from several laboratories must be combined in a way that resolves any differences in taxonomy or analytical technique. The laboratories used agreed nomenclature and standardized identifications by using quality control techniques. The database will allow further exploration of diatom-water quality data as samples from a wider range of environmental gradients are included and the full range of chemical data is screened in the same way as the hydrogen ion concentration values. (Brunone-PTT)
W90-08101

DIATOMS AND PH RECONSTRUCTION.
Bergen Univ. (Norway). Botanical Inst.
H. J. B. Birks, J. M. Line, S. Juggins, A. C. Stevenson, and C. J. F. ter Braak.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 263-278, March 12, 1990. 2 fig, 3 tab, 41 ref, append.

Descriptors: *Acid rain, *Diatoms, *Hydrogen ion concentration, *Limnology, *Paleolimnology, *Statistical analysis, Bootstrapping, Calibrations, Lake acidification, Model studies, Population dynamics, Prediction, Regression analysis, Sediment analysis, Species composition, Surface Water Acidification Project.

Paleolimnological diatom data comprise counts of many species expressed as percentages for each sample. Reconstruction of past lake-water hydrogen ion concentration from such data involves two steps; (i) regression, where responses of modern diatom abundances to hydrogen ion concentration are modelled and (ii) calibration where the modeled responses are used to infer hydrogen ion concentration from diatom assemblages preserved in lake sediments. In view of the highly multivariate nature of diatom data, the strongly nonlinear response of diatoms to hydrogen ion concentration, and the abundance of zero values in the data, a compromise between ecological realism and computational feasibility is essential. The two numerical approaches used are (i) the computationally demanding but formal statistical approach of maximum likelihood Gaussian logit regression and calibration and (ii) the computationally straightforward but heuristic approach of weighted averaging regression and calibration. When the Surface Water Acidification Project (SWAP) modern training set of 178 lakes is reduced by data-screening to 167 lakes, weighted averaging gives superior results in terms of lowest root mean squared errors of prediction in cross-validation. Bootstrapping is also used to derive prediction errors, not only for the training set as a whole but also for individual hydrogen ion concentration reconstructions by weighted averaging for stratigraphic samples from Round Loch of Glenhead, southwest Scotland covering the last 10,000 years. (Author's abstract)
W90-08102

DISSOLVED ORGANIC CARBON RECONSTRUCTIONS FROM DIATOM ASSEMBLAGES IN PIRLA PROJECT LAKES, NORTH AMERICA.
Queen's Univ., Kingston (Ontario). Dept. of Biology.
J. C. Kingston, and H. J. B. Birks.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 279-288, March 12, 1990. 1 fig, 4 tab, 37 ref.

Descriptors: *Acid rain, *Diatoms, *Dissolved organic carbon, *Limnology, *Paleoecological Investigation of Recent, *Paleolimnology, *Regression analysis, Bioindicators, Calibration, Hydrogen ion concentration, Lake acidification, Mathematical models, North America, Species composition.

Diatom-based paleolimnological reconstructions of dissolved organic carbon (DOC) are presented for four regional data sets of the North American 'Paleoecological Investigation of Recent Lake Acidification' (PIRLA) project, and for a combined, three-region set. Species optima and tolerances along the DOC gradient were estimated by using maximum likelihood and weighted averages regression. Weighted-averages regression appears to be the most robust and tractable technique for estimating optima, and the apparent error (mean standard error of the relation) was as good for weighted-averaging calibration as for maximum likelihood calibration. Calculated species optima are not entirely consistent among regions and the best 'indicators' for DOC in the PIRLA data-sets are not in good agreement with those found in the literature. Example reconstructions demonstrate that DOC changes are often less than 100 micromoles/L, and that the DOC declines in some recently acidified lakes parallel reconstructed hydrogen ion concentration declines. (Author's abstract)
W90-08103

RECENT ACIDIFICATION AND CHANGES IN THE SUBFOSSIL CHRYSOPHYTE FLORA OF LAKES IN SWEDEN, NORWAY AND SCOTLAND.
Lund Univ. (Sweden). Inst. of Ecology.
G. Cronberg.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p , March 12, 1990.

Descriptors: *Acid rain, *Chrysophyta, *Lake acidification, *Norway, *Paleolimnology, *Scotland, *Sweden, Aquatic environment, Ecosystems, Sediment analysis, Species composition.

The subfossil chrysophyte flora was investigated in sediment cores from eight lakes in Scotland and Scandinavia (Lochan Uaine, Lochan Dubh, Loch Doilet, Loch Tinker and Loch Chon in Scotland, Royrtjorna and Verevatn in Norway, and Lilla Oresjon in Sweden). In the Scottish lakes, scales were rare or absent. However, Scandinavian lakes contained numerous different chrysophyte scales. In Lilla Oresjon and Verevatn, the changes in the subfossil chrysophyte community reflect the recent acidification of these lakes. (Author's abstract)
W90-08104

MIDGE FAUNA DEVELOPMENT IN ACIDIFIED LAKES IN NORTHERN EUROPE.
National Swedish Environment Protection Board, Solna.
Y. W. Brodin.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 295-298, March 12, 1990. 1 fig, 1 tab, 10 ref.

Descriptors: *Acid rain effects, *Europe, *Lake acidification, *Limnology, *Midges, *Species diversity, Aquatic environment, Oligotrophic lakes, Productivity, Species composition, Stratigraphy, Survival.

The recent acidification of lakes has exerted profound effects on aquatic fauna, the most obvious consequences being decreased animal diversity and elimination of several species. Analyses of stratigraphical sedimentary remains of aquatic midges (Chironomidae, Chaoboridae, and Ceratopogonidae) revealed pronounced faunal changes attributable to acidification in north European lakes from about 1850 and onwards. The present study includes lakes in Scotland (Round Loch, Loch Tinker, and Loch Chon), Norway (Verevatn) and Sweden (Lilla Oresjon). Increased lake acidification during this century generally caused a reduction of midge fauna stability, diversity, productivity, and survival rate. The similarity of chironomid species composition between lakes increased. Changes in chironomid species also revealed that oligotrophication is a typical feature of acidified lakes. (Brunone-PTT)
W90-08105

RECENT LAKE ACIDIFICATION AND CLADOCERAN DYNAMICS: SURFACE SEDIMENT AND CORE ANALYSES FROM LAKES IN NORWAY, SCOTLAND AND SWEDEN.
Oslo Univ. (Norway). Biologisk Inst.
J. P. Nilssen, and S. Sandoy.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 290-293, March 12, 1990.

Descriptors: *Acid rain, *Lake acidification, *Limnology, *Norway, *Scotland, *Sediment analysis, *Sweden, *Waterfleas, Aluminum, Aquatic plants, Fish populations, Hydrogen ion concentration, Population dynamics, Species composition, Species diversity, Trophic level.

To interpret remains of Cladocera in lake sediments in relation to hydrogen ion concentration history, fish abundance, vegetation change, trophic level change and other historic events, it is necessary to understand the balance of abiotic and biotic forces responsible for their present distribution, population dynamics and morphological types. Once these factors are understood, past lake condi-

tions can be inferred from them. Many cladoceran species are influenced by fish and invertebrate predation. Some species, especially in the plankton, also show a clear physiological relation to hydrogen ion concentration and aluminum levels in lakes. Moreover, several littoral-benthic species have a habitat distribution restricted to rock, sand, mud, vegetation, or a combination of some of these. Remains of littoral and planktonic cladocerans were analyzed in surface sediments of 18 Norwegian lakes with hydrogen ion concentrations ranging from 4.5-7.5. In addition, sediment cores from four sites in Norway, four in Scotland, and one in Sweden were analyzed. The majority of sites showed evidence of recent acidification. In lakes with non-planktivorous fish, analyses of cladoceran remains gave no information on past fish populations, but indicated the hydrogen ion concentration history of the lakes. In lakes with present or past populations of planktivorous fish, the cladoceran record could be used to assess past fish status as well as past hydrogen ion concentration. In some lakes, changes in the cladoceran communities could be related to changes in macrophyte distribution. (Author's abstract)
W90-08106

SEDIMENT CHEMISTRY AND ATMOSPHERIC CONTAMINATION.
Ulster Univ., Coleraine (Northern Ireland). Limnology Lab.
For primary bibliographic entry see Field 5B.
W90-08107

BRITISH AND SCANDINAVIAN LAKE SEDIMENT RECORDS OF CARBONACEOUS PARTICLES FROM FOSSIL-FUEL COMBUSTION.
Umea Univ. (Sweden). Dept. of Ecological Botany.
M. Wik, and J. Natkanski.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 319-323, March 12, 1990. 1 fig, 17 ref.

Descriptors: *Acid rain, *Air pollution, *Lake sediments, *Norway, *Paleolimnology, *Particulate matter, *Path of pollutants, *Scotland, *Sweden, Concentration profiles, Fuel, Nitrogen compounds, Polycyclic aromatic hydrocarbons, Sediment analysis, Spheroidal carbonaceous particles, Sulfur dioxide.

Spheroidal carbonaceous particles (particulate matter together with sulfur dioxide, nitrogen oxides, polycyclic aromatic hydrocarbons and metals) are emitted to the atmosphere during oil and coal combustion. The sedimentary record of these particles has been analyzed for six Scottish (Loch Chon, Loch Doilet, Loch Tinker, Lochan Uaine, Lochan Dubh, and Round Loch), two Norwegian (Verevatn and Royrtjorna) and one Swedish (Lilla Oresjon) lake. Concentration profiles in the sediment parallel fuel-consumption trends. There are also large differences in carbonaceous particulate concentrations indicating geographical differences in loading of air pollutants from fossil-fuel combustion. (Author's abstract)
W90-08108

LAKE SEDIMENT MAGNETISM AND ATMOSPHERIC DEPOSITION.
Liverpool Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W90-08109

RECORD OF ATMOSPHERIC DEPOSITION ON A RAINWATER-DEPENDENT PEATLAND.
Queen Mary Coll., London (England). School of Biological Sciences.
R. S. Clymo, F. Oldfield, P. G. Appleby, G. W. Pearson, and P. Ratnesar.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 331-338, March 12, 1990. 4 fig, 1 tab, 6 ref.

Descriptors: *Acid rain, *Air pollution, *Path of pollutants, *Peat bogs, Carbon radioisotopes, Con-

centration profiles, Minerals, Scotland, Sediment analysis, Vertical distribution.

Rainwater-dependent peatlands retain a record of atmospheric deposition. Unlike lake sediments, they record both particulate and soluble influxes, and they are not complicated by processes in the catchment or by mineral particle influx from the catchment. They do, however, have their own difficulties. The timescale for cores from a suitable peatland in southwest Scotland was established by a combination of carbon-14 'wiggle-matching', pollen events, lead-210 dating and the americium-241 event. Retention of deposited elements varied greatly from less than 1% (sodium) to complete retention (nitrogen). Hummocks retained more than hollows: the quotient was 1.2-1.8 for elements such as aluminum (associated with particles) and up to 5-10 for manganese, iron, and zinc. The vertical scale in profiles should be as cumulative dry mass or, better, as dry mass after reconstructing losses by decay. These give vertical scales that are approximately linear with age. Elements differ greatly in the shape of their concentration profiles as a result of varying influx and as a result of relocation in the peat. (Author's abstract)
W90-08110

CAUSES OF LAKE ACIDIFICATION, WITH SPECIAL REFERENCE TO THE ROLE OF ACID DEPOSITION.
University Coll., London (England). Palaeoecology Research Unit.
R. W. Battarbee.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 339-347, March 12, 1990. 3 fig, 26 ref.

Descriptors: *Acid rain, *Air pollution, *Europe, *Lake acidification, *Paleolimnology, *Path of pollutants, Calcium, Carbonaceous particles, Catchment burning, Forest watersheds, Grazing, Hydrogen ion concentration, Sulfur, Trace metals.

Acid surface waters (hydrogen ion concentration < 5.5) occur throughout western and northern Europe. The claim that many of these waters have been acidified in recent decades and that the acidification results from acid deposition has been well-substantiated by paleolimnological studies. At almost all sites acidification post-dates 1800 a.d.; it is accompanied by increases in the concentration of trace metals and carbonaceous particles and the spatial pattern of acidified lakes coincides with areas of high acid deposition (greater than 0.5 g s/sq m/yr). Very sensitive sites (calcium ion < 50 microequivalents/L) in areas of low acid deposition are not acidified. Paleolimnological tests to evaluate the contribution of other factors suggest that leaching and paludification processes are important on a post-glacial time scale but imperceptible over the last 200 years, and that alterations to catchment burning and grazing regimes over this time scale have little or no effect. Only the afforestation of sensitive catchments in areas of high sulfur deposition appears to be significant, an effect attributed to the enhanced sulfur-scavenging efficiency of the forest canopy rather than to the direct effect of forest growth. (Author's abstract)
W90-08111

DEVOKE WATER AND LOCH SIONASCAIG: RECENT ENVIRONMENTAL CHANGES AND THE POST-GLACIAL OVERVIEW.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
K. M. Atkinson, and E. Y. Haworth.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 349-355, March 12, 1990. 2 fig, 2 tab, 12 ref.

Descriptors: *Acid rain, *Diatoms, *England, *Lake acidification, *Paleolimnology, *Radioactive dating, *Scotland, Alkalinity, Oligotrophic lakes, Sediment analysis, Species composition.

Diatoms for postglacial sediments of two oligotrophic lakes, one in northwest England (Devoke Water) and one in northwest Scotland (Loch Sion-

ascaig), were examined. Cores of the upper 1 m of sediment were collected from Devoke Water (mid-lake area in 9 m) and Loch Sionascaig (towards the eastern end in 21 m of water) by using a Mackereth minicorer. The cores were analyzed for diatoms and radioisotopes. The pH at various levels in the cores was inferred from diatom species assemblages. The levels at which these assemblages occurred were dated using lead-210, cesium-137, and/or americium-241. Previously-published reports were relied used for interpretation of deeper sediments. Apart from a decline of alkalinity in the early post-glacial period at both sites, the only evidence for further increase in acidity occurs in the post-1900 sediments of Devoke Water (Cumbria). There has been no such change in Loch Sionascaig, in a region of lower acid deposition in northwest Scotland. (Brunone-PTT)
W90-08112

12,600 YEAR PERSPECTIVE OF THE ACIDIFICATION OF LILLA ORESJON, SOUTHWEST SWEDEN.
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 5B.
W90-08113

SIGNIFICANCE OF LAND-USE AND LAND-MANAGEMENT CHANGE IN THE ACIDIFICATION OF LAKES IN SCOTLAND AND NORWAY: AN ASSESSMENT UTILIZING DOCUMENTARY SOURCES AND POLLEN ANALYSIS.
University Coll., London (England). Palaeoecology Research Unit.
S. T. Patrick, J. A. Timberlid, and A. C. Stevenson.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 363-367, March 12, 1990. 2 fig, 12 ref.

Descriptors: *Acid rain effects, *Lake acidification, *Land management, *Land use, *Norway, *Paleolimnology, *Palynology, *Scotland, Acid rain, Air pollution, Grazing, Path of pollutants, Plant populations, Species composition.

Documentary sources reveal that various land-use and management changes in the catchments of six Scottish lakes (Round Loch, Loch Chon, Loch Tinker, Loch Doilet, Lochan Dubh, Lochan Uaine) during the past 200 years cannot be related to the acidification of specific lakes nor can acidification be related to any general 'land-use' hypothesis. At five of the sites these conclusions are supported by pollen-derived reconstruction of catchment vegetation. In Norway, documentary evidence fails to support a 'land-use' hypothesis of acidification as grazing intensity has actually increased in the area where waters are most strongly acidified. The failure to attribute acidification to catchment processes provides further evidence for an explanation in terms of acid precipitation. (Author's abstract)
W90-08114

LAND-USE CHANGE AND LAKE ACIDIFICATION: IRON AGE DE-SETTLEMENT IN NORTHERN SWEDEN AS A PRE-INDUSTRIAL ANALOGUE.
Umea Univ. (Sweden). Dept. of Ecological Botany.
N. J. Anderson, and T. Korman.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 373-376, March 12, 1990. 2 fig, 12 ref.

Descriptors: *Acid rain effects, *Lake acidification, *Land use, *Paleolimnology, *Sediment analysis, *Sweden, Agriculture, Air pollution, Archaeology, Decomposing organic matter, Diatoms, History, Human population, Hydrogen ion concentration, Iron Age, Liming, Palynology, Path of pollutants, Vegetation effects, Watersheds.

Iron Age de-settlement in Halsingland, Northern Sweden, can be regarded as a good analogue for the possible effects of land-use and vegetational changes on lake acidification without the effect of contemporary atmospheric pollution. Pollen analyses were used to identify vegetational change associated with a de-settlement period circa 500 A.D. and diatom analyses to assess if there was any associated change in lake-water hydrogen ion concentrations. A clear settlement horizon was found in the two lakes studied, indicating catchment disturbance associated with Iron Age agriculture. There was no change, however, in diatom reconstructed hydrogen ion concentrations after de-settlement, during vegetation regeneration, when it has been postulated that the buildup of raw humus and change of ion-exchange conditions would result in acidification. Importantly, one of the lakes began to acidify, before liming, under contemporary levels of acid deposition. (Author's abstract)
W90-08115

AFFORESTATION AND LAKE ACIDIFICATION: A COMPARISON OF FOUR SITES IN SCOTLAND.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 5C.
W90-08116

PALAEOLIMNOLOGICAL CHANGES RELATED TO ACID DEPOSITION AND LAND-USE IN THE CATCHMENTS OF TWO NORWEGIAN SOFT-WATER LAKES.
National Swedish Environment Protection Board, Solna.
For primary bibliographic entry see Field 5C.
W90-08117

RECENT ACIDIFICATION AND BIOLOGICAL CHANGES IN LILLA ORESJON, SOUTHWEST SWEDEN, AND THE RELATION TO ATMOSPHERIC POLLUTION AND LAND-USE HISTORY.
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 5C.
W90-08118

RECENT PALAEOLIMNOLOGY OF TWO SITES WITH CONTRASTING ACID-DEPOSITION HISTORIES.
University Coll., London (England). Palaeoecology Research Unit.
V. J. Jones, A. M. Kreiser, P. G. Appleby, Y. W. Brodin, and J. Dayton.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 397-402, March 12, 1990. 2 fig, 11 ref.

Descriptors: *Acid rain, *Air pollution effects, *Lake acidification, *Paleoecology, *Paleolimnology, *Sulfur, Air pollution, Atmospheric chemistry, Hydrogen ion concentration, Loch Dubh, Path of pollutants, Round Loch, Scotland.

A paleoecological comparison is made between geologically sensitive sites chosen from an area of low sulfur deposition (Lochan Dubh) and an area of high sulfur deposition (Round Loch of Glenhead). Pre-industrial (pre-1800) acidities of the lakes were similar but the hydrogen ion concentration of the Round Loch of Glenhead has subsequently dropped by over 0.5 of a pH unit whereas the hydrogen ion concentration of Lochan Dubh has only decreased slightly. The record of atmospheric contamination confirms that the Round Loch of Glenhead is a more heavily polluted site than Lochan Dubh. The increased degree of lake acidification and higher levels of atmospheric contamination at the Round Loch of Glenhead are correlated with the greater sulfur deposition levels at this site. (Author's abstract)
W90-08119

EFFECTS OF ACIDIC DEPOSITION ON NORTH AMERICAN LAKES: PALAEOLIMNO-

LOGICAL EVIDENCE FROM DIATOMS AND CHRYSOPHYTES.
Indiana Univ. at Bloomington. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W90-08120

ALKALINITY AND PH OF THREE LAKES IN NORTHERN NEW ENGLAND, U.S.A., OVER THE PAST 300 YEARS.
Maine Univ., Orono. Dept. of Botany and Plant Pathology.
R. B. Davis, D. S. Anderson, M. C. Whiting, J. P. Smol, and S. S. Dixit.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 413-421, March 12, 1990. 3 fig, 2 tab, 21 ref.

Descriptors: *Acid rain effects, *Alkalinity, *History, *Lake acidification, *Maine, *Paleolimnology, *Sediment analysis, *Vermont, Air pollution, Calibrations, Canonical correlation analysis, Chrysophyta, Cluster analysis, Detrended correspondence analysis, Diatoms, Hydrogen ion concentration, Lead, Path of pollutants, Polycyclic aromatic hydrocarbons, Species composition.

Three-hundred-year histories of hydrogen ion concentration and total alkalinity (alk) have been inferred from diatom and chrysophyte remains in deep-water sediment cores from Mud Pond and Little Long Pond, Maine and Haystack Pond, Vermont. Three replicate cores each were studied from Mud Pond and Haystack Pond; one sediment core from Little Long Pond; hydrogen ion concentrations and alk inferences from diatoms were based upon three different calibration equations: CLUSTER, detrended correspondence analysis (DECORANA) and canonical correlation analysis (CANOCO). There were minor differences between chrysophyte-based and diatom-based inferences, but both led to similar conclusions regarding acidification. These were: Mud Pond, circa 1700-1925, hydrogen ion concentration 5.2-5.3, alk 0 to 0 - 15 microequivalents/L; 1925-1970, acidification to approximately 4.8 and alk -20 to -30 microequivalents/L. Little Long Pond circa 1700-1950, hydrogen ion concentration approximately 5.9, alk 20-50 microequivalents/L; 1950, possible slight acidification to 5.7-5.8. Haystack Pond circa 1700-1925, hydrogen ion concentration 5.2-5.3, alk 0 to -10 microequivalents/L; 1925-1970, acidification to approximately 4.9 and alk -10 to -30 microequivalents/L. Correlation of lake acidification with great increases in sedimentary indicators of air pollution (carbonaceous particles, lead, polycyclic aromatic hydrocarbons) and absence of correlated catchment disturbance point to anthropogenic acid deposition as the cause of lake acidification. (Author's abstract)
W90-08121

LAKE ACIDIFICATION IN FINLAND.
Joensuu Univ. (Finland).
J. Merilainen, and P. Huttunen.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 423-425, March 12, 1990. 1 fig, 20 ref.

Descriptors: *Acid rain effects, *Finland, *Lake acidification, *Sediment chemistry, *Water chemistry, Air pollution, Diatoms, History, Paleolimnology, Path of pollutants, Seasonal variation, Species composition, Water quality control.

Lake water was sampled during the summer stagnation and autumn turnover periods and the surface sediments were sampled in winter through the ice in 1978 in eastern Finland on 151 lakes. The relationship between water chemistry and diatom assemblages was investigated. Twenty-three of the lakes had clearly acidified during this century, and the remaining sites were naturally acid or indicated some slight acidification. For natural reasons, most Finnish lakes are very vulnerable to acid deposition. Almost half of the study sites have lost a substantial portion of their buffering capacity during the last three decades. Though serious, recent acidification in Finland has not yet led to widespread damage, but the threat is real and

almost all aquatic systems might be affected if acid deposition increases further. Despite the clear link between acid deposition and lake acidification, future paleolimnological research in Finland should be more focused on the causes of acidification. Only then can defense strategies against the acidification problem be effectively constructed. (Brunone-PTT)
W90-08122

POST-1970 WATER-CHEMISTRY CHANGES AND PALAEOLIMNOLOGY OF SEVERAL ACIDIFIED UPLAND LAKES IN THE U.K.
University Coll., London (England). Palaeoecology Research Unit.
R. J. Flower, N. G. Cameron, N. Rose, S. C. Fritz, and R. Harriman.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 427-433, March 12, 1990. 2 fig, 1 tab, 22 ref.

Descriptors: *Acid rain effects, *Lake acidification, *Paleolimnology, *Scotland, *Wales, *Water quality trends, Acid rain, Air pollution, Carbonaceous particles, Diatoms, Fertilizers, Forest management, Hydrogen ion concentration, Lake restoration, Liming, Path of pollutants, Sediment analysis, Species composition, Sulfur.

Responses of four lakes to post-1970 changes in acid deposition, afforestation and liming are examined by using water quality measurements and paleolimnological analysis. Hydrogen ion concentrations and non-marine sulfate concentrations at an undisturbed site approximately parallel trends in precipitation and indicate that lake water quality has improved since the late-1970s as atmospheric sulfur emissions have declined. Carbonaceous particle contamination of the lake also declined in this period but diatom analysis shows that the ecological response to these changes are as yet small. However, at a similar but recently afforested site, major changes in sedimentary diatoms have occurred and the cause may be fertilizer leaching. At the two limed sites, the diatom response is proportional to liming intensity but at neither site has the pre-acidification diatom flora been re-established. (Author's abstract)
W90-08123

MODELLING LONG-TERM ACIDIFICATION: A COMPARISON WITH DIATOM RECONSTRUCTIONS AND THE IMPLICATIONS FOR REVERSIBILITY.
Institute of Hydrology, Wallingford (England).
A. Jenkins, P. G. Whitehead, B. J. Cosby, and H. J. B. Birks.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 435-440, March 12, 1990. 2 fig, 1 tab, 12 ref.

Descriptors: *Acid rain, *Diatoms, *Lake acidification, *Mathematical models, *Model studies, *Paleolimnology, Afforestation, Forest management, History, Hydrogen ion concentration, Lake restoration, Land use, Pollution, Scotland, Simulation analysis, Water quality trends.

A model of long term acidification (MAGIC) is applied to a range of catchments in Scotland that are subject to different pollution inputs and land uses. The simulated historical trends in hydrogen ion concentrations are compared with data from paleolimnological reconstructions undertaken at the same sites. Both techniques produce similar historical acidification trends and, with some exceptions, closely match observed present day hydrogen ion concentrations. The MAGIC model results indicate that pollution inputs and land-use, particularly afforestation, have significant effects on surface water quality. Moreover, the model indicates that reversibility may be occurring at several sites. Reversibility of acidification is further explored by using the model in predictive mode under several scenarios for reduction deposition. (Author's abstract)
W90-08124

Group 2H—Lakes

PALAEOLIMNOLOGY AND LAKE ACIDIFI-CATION: A SUMMARY.
Bergen Univ. (Norway). Botanical Inst.
K. Faegri.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 441-445, March 12, 1990.

Descriptors: *Acid rain effects, *Industrial wastes, *Lake acidification, *Paleolimnology, Acid rain, Air pollution, Bioindicators, Climates, Diatoms, Land use, Palynology, Species composition, Water chemistry, Water quality trends.

Three hypotheses have been put forward to account for lake acidification: long-term acidification, effect of changes in land-use, and effects of industrial pollution. Within the general ecological framework, hydrogen ion concentration monitors the general status of the basins studied. A monitoring system that is robust makes it possible to trace the beginnings of acidification. Many organisms are more sensitive indicators than ecochemical measurements. Flowering of trees, as registered by pollen analysis, registers climatic deterioration almost instantaneously. However, the complicated physiological pathways of multicellular terrestrial organisms put them at a disadvantage in comparison with small, often unicellular aquatic organisms, the time-lag of whose reaction is very short. If, in addition, such organisms are specifically recognizable after death and sufficiently resistant against decay and occur in large numbers, they are ideal index fossils. Any paleolimnological investigation that includes necessary and suitable organisms immediately recognizes the onset of ecological change by changes in the numerical relations between groups of taxa. As a group, diatoms may be the most versatile and reliable monitoring organisms available. They possess the qualities defined for the ideal index fossil. The reactions of diatoms and other biota to acidification is not influenced by the way in which this acidity has arisen, only on its existence. Studies of paired lakes (those with land-use influence and those without) and indicators of atmospheric pollution give positive evidence for the atmospheric pollution hypothesis, but do not completely rule out the land-use hypothesis. (Brunone-PTT)
W90-08125

WATER POLLUTION BIOLOGY: A LABORATORY/FIELD HANDBOOK.
Massachusetts Univ., Amherst.
For primary bibliographic entry see Field 5C.
W90-08173

PHYSICAL AND CHEMICAL PROPERTIES OF ASWAN HIGH DAM LAKE WATER.
R. M. Awadallah.
Water SA WASADV, Vol. 16, No. 1, p 79-84, January 1990. 2 fig, 1 tab, 35 ref.

Descriptors: *Aswan Dam, *Chemical properties, *Lakes, *Physical properties, *Reservoirs, Bottom water, Conductivity, Dissolved oxygen, Dissolved solids, Egypt, Fertility, Fish populations, Hardness, Hydrogen ion concentration, Ions, Lake stratification, Microorganisms, Sudan, Surface water data, Water management, Water quality, Water sampling, Water temperature.

The distribution of certain chemical components in water bodies may provide useful information regarding water movements, or may give an indication of the factors controlling the fertility of the water masses for the growth of microorganisms and fish. During the period from July 1, 1980 to July 24, 1980 water samples were collected from nineteen stations between Daal Cataract in Sudan and the High Dam wall in the southernmost part of Egypt. Electrical conductivity, temperature, and pH were measured, in conjunction with dissolved oxygen, CO3(-2), HCO3(-), ClSO4(-2), SiO2, Na, Ca, Mg, total hardness (TH) and total dissolved solids (TDS) in the entire body of water in order to follow up the physical and chemical changes and their effects on the water quality, on the growth of the microorganism communities and hence, on fish living in the lake. It was revealed that the temperature ranged from 19.0 to 29.1 C in

the Sudan and 19.2 to 28.2 C on the Egyptian side; conductivity was in the range 2.30 to 3.40 mS/m; pH was in the range from 8.0 to 8.9; dissolved oxygen was in the range from 1.0 to 8.0 mg/L; TDS: 138 to 193 mg/L; Cl: 4.2 to 9.7 mg/L; free CO2: 0 mg/L; CO3(-2): 0 to 15 mg/L HCO3(-): 103.7 to 174 mg/L; SO4(-2): 6.35 to 1.5 mg/L; SiO2: 7 to 15 mg/L; Ca: 17.6 to 24.39 mg/L; Mg: 8.3 to 9.7 mg/L; Na: 17.6 to 33.6 mg/L; and TH: 53.70 to 135.27 mg/L for surface and bottom waters. On the basis of the results there was a stratification in the water masses of the lake. (Author's abstract)
W90-08234

CLASSIFICATION OF 20 ANDEAN-PATAGONIAN (ARGENTINA) BODIES OF WATER BASED ON SUMMER PHYTOPLANKTON STRUCTURE (CLASIFICACION DE 20 CUERPOS DE AGUA ANDINO-PATAGONICOS (ARGENTINA) EN BASE A LA ESTRUCTURA DEL FITOPLANCTON ESTIVAL).
Buenos Aires Univ. (Argentina). Dept. Ciencias Biologicas.
I. Izaguirre, P. del Giorgio, I. O'Farrell, and G. Tell.
Cryptogamie Algologie CRALD9, Vol. 11, No. 1, p 31-46, February 1990. 3 fig, 2 tab, 44 ref. English summary.

Descriptors: *Algae, *Argentina, *Limnology, *Phytoplankton, *Species composition, *Taxonomy, Cluster analysis, Lake morphology, Lakes, Patagonia.

The phytoplankton communities of 20 Patagonian lakes (Argentina) were sampled during the summer of 1984. For the whole of these lakes, 254 taxa were registered allowing a better knowledge of their distribution in the southern hemisphere. A selected subset of 46 dominant taxa was used to perform a cluster analysis of lakes. By taking into consideration both the abundance and distribution of phytoplankton, two distinct groups of lakes could be distinguished: oligotrophic Andean lakes on the one hand and meso-eutrophic lakes located in the preandean area and Patagonian plateau. Moreover, the same subset of species was clustered yielding algal associations which are characteristic of the different lake types. Statistical analysis showed that phytoplankton density was significantly lower in the Andean group of lakes, and for all the lakes studied it was found to be inversely correlated to the relative depth (Z). This paper emphasizes lake morphometry as one of the principal factors influencing the composition and density of phytoplankton. (Author's abstract)
W90-08265

SUITABILITY OF TWO-PARAMETER GAMMA AND THREE-PARAMETER BETA DISTRIBUTIONS AS SYNTHETIC UNIT HYDROGRAPHS IN ANATOLIA.
Cukurova Univ., Adana (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-08268

BIOLOGY OF BAIKAL OMUL, COREGONUS AUTUMNALIS MIGRATORIUS, IN BRATSK RESERVOIR.
Institute of Fisheries Research and Management, Ulan-Ude (USSR).
For primary bibliographic entry see Field 8I.
W90-08291

AMUR BREAM, PARABRAMIS PEKINESIS, IN THE AMU DARYA LOWLAND WATER BODIES.
Karakalpakskii Kompleksnyi Nauchno-Issledovatelskii Inst., Nukus (USSR).
For primary bibliographic entry see Field 8I.
W90-08292

SEQUENTIAL FRACTIONATION OF SEDIMENT PHOSPHATE.
Leiden Rijksuniversiteit (Netherlands). Dept. of Population Biology.

For primary bibliographic entry see Field 2K.
W90-08308

DYNAMICS OF SESTON CONSTITUANTS IN THE ARIEGE AND GARONNE RIVERS (FRANCE).
Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Ressources Renouvelables.
For primary bibliographic entry see Field 2E.
W90-08311

INFLUENCE OF LIME AND BIOLOGICAL ACTIVITY ON SEDIMENT PH, REDOX AND PHOSPHOROUS DYNAMICS.
Bergen Univ. (Norway). Zoological Museum.
For primary bibliographic entry see Field 5G.
W90-08312

FACTORS INFLUENCING RESPIRATION DATA IN FRESHWATER SEDIMENT.
Guelph Univ. (Ontario). Dept. of Environmental Biology.
C. A. Flemming, and J. T. Trevors.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 205-214, March 15, 1990. 6 fig, 26 ref.

Descriptors: *Freshwater, *Respiration, *Sediment chemistry, Carbon dioxide, Laboratory methods, Oxygen, Temperature.

Sediment respiration (oxygen consumption and CO2 evolution) was measured in freshwater sediment samples using both flask-microcosms and core-microcosms, and the estimates were compared. Oxygen consumption data were also compared in flask-microcosms constructed with sediment samples of different masses, sediment:water ratios, and storage times. Furthermore, sediment respiration was examined under different incubation conditions of temperature and agitation. O2 consumpiion was markedly higher in flask-microcosms than in sediment core-microcosms, when compared on a per g dry weight basis. However, when the results were expressed as O2 consumed per unit surface area, the values were more similar. CO2 evolution was less dependent on surface area as evidenced by similar CO2 values per g sediment in both microcosms. In addition, the effect of sediment mass on O2 consumption and CO2 evolution was examined. Both O2 consumption and CO2 evolution (expressed as micromole/g dry weight sediment) decreased significantly with increasing sediment mass between 3 and 12 g dry weight. Maximum O2 consumption per unit headspace was measured when a wet sediment mass between 10.0 and 20.0 g was used in the flask-microcosms. It was also shown that the sediment:water ratio, agitation, incubation temperature, and previous storage time of sediment all affected the respiration estimates. Initial O2 consumption and CO2 evolution in flasks were significantly higher in flasks with a decreased sediment:water ratio (1:1 versus 1:2), increased flask agitation, and increased incubation temperature (15 C versus 5 C). Also, respiration decreased significantly over the first 100 days of storage at 4 C. (Author's abstract)
W90-08313

CALCITE SUPERSATURATION IN SOME SUBTROPICAL, KASHMIR, HIMALAYAN LAKES.
Freshwater Biological Association, Ambleside (England).
V. K. Koul, W. Davison, and D. P. Zutshi.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 215-222, March 15, 1990. 6 fig, 1 tab, 23 ref.

Descriptors: *Calcite, *Chemical precipitation, *Limnology, *Water chemistry, Alkalinity, Calcium, Hydrogen ion concentration, Kashmir, Khanpur Lake, Seasonal variation, Tilwan Lake, Trigam Lake.

Results of a two year study of the detailed water chemistry of three productive, Kashmir, Himalayan Lakes, Khanpur, Trigam and Tilwan (average alt. 1580 m), are used to provide an appreciation of

the role of calcite precipitation. Each lake shows distinct but dissimilar seasonal variations in the concentration of calcium and alkalinity. Seasonal changes in saturation index show that the mechanism which controls the concentration of calcium and alkalinity is different in each lake. In the least productive Khanpur Lake the waters are always close to saturation with respect to calcite. The elevation of pH by photosynthetic activity shows a systematic seasonal variation and is instrumental in controlling the concentration of calcium and alkalinity. By contrast Trigam Lake is exceedingly productive, the pH is high and constant and the lake is always markedly supersaturated. The seasonal variations in calcium and alkalinity appear to be controlled by seasonal changes in temperature. This implies that the rate of precipitation of calcite depends on the degree of supersaturation. The third lake, Tilwan, which has an intermediate level of supersaturation shows a complicated seasonal chemistry, combining the effects observed in the other two lakes. (Author's abstract)
W90-08314

IN VITRO AND IN SITU STUDIES ON NITRATE DISAPPEARANCE IN WATER-SEDIMENT SYSTEMS OF THE CAMARGUE (SOUTHERN FRANCE).
Station Biologique de la Tour du Valat, Arles (France).
H. El-Habr, and H. L. Golterman.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 223-232, March 15, 1990. 6 fig, 2 tab, 17 ref.

Descriptors: *In situ tests, *In vitro tests, *Nitrates, *Sediment-water interfaces, Denitrification, France, Ile de la Camargue, Nitrogen, Organic matter, Seasonal variation, Temperature.

In vitro and in situ experiments were conducted on nitrate disappearance from water-sediment systems in the Camargue. In the in vitro experiments two factors were studied: temperature and organic matter. After a first addition of KNO3 to these sediments, the concentration of organic matter exerted a strong influence on the disappearance rate of nitrate at 25 C and 15 C but not at 2 C. After a second addition of nitrate at 25 C and 15 C the denitrification rate increased by approximately 10%, probably because the activity of the bacterial population had increased. Experiments in situ in freshwater temporary marshes showed that nitrate disappeared at approximately twice the rate at similar temperatures in vitro. After the first addition of nitrate in the in vitro experiments the concentration of nitrite in the water above the sediment reached about 10% of the concentration of total dissolved inorganic nitrogen at 2 C and 15 C. These high concentrations were not found after the first addition at 25 C or after the second addition of nitrate at 25 C and 15 C. In the in situ experiments, however, high concentrations of nitrite were found. These results show the importance of the reduction of nitrate in natural ecosystems of the camargue, which receive nitrate during two periods: the first in August-September, with the refilling of the temporary marshes with Rhone water, and the second during winter, with the mineralization of organic matter. This implies significant losses of nitrogen; during the first supply, when the temperature is still high, the loss of nitrate will be due to a rapid denitrification, whereas during the winter, this process will slow down, but will not become zero, and may last for a considerable period, as there is no competing vegetation. (Author's abstract)
W90-08315

FACTORS INFLUENCING PHOSPHATE EXCHANGE ACROSS THE SEDIMENT-WATER INTERFACE OF EUTROPHIC RESERVOIRS.
Essex Univ., Colchester (England). Dept. of Biology.
For primary bibliographic entry see Field 5G.
W90-08316

PORE WATER DYNAMICS IN THE SEDIMENT OF A SHALLOW AND HYPERTROPHIC LAKE.
National Environmental Research Inst., Silkeborg (Denmark). Div. of Freshwater Ecology.
M. Sondergaard.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 247-258, March 15, 1990. 8 fig, 2 tab, 39 ref.

Descriptors: *Interstitial water, *Lake Sobygaard, *Lake sediments, *Limnology, *Nutrients, *Phosphorus, Denmark, Hydrogen ion concentration, Seasonal variation, Sediment-water interfaces.

Seasonal variations in pore water with main stress on pH and phosphate were investigated in the sediment of the shallow and hypertrophic Lake Sobygaard, Denmark. The purpose was to evaluate factors affecting the internal phosphorus loading. Pore water was obtained by in situ incubation of ceramic cups, sampled anaerobically from a fixed position in the sediment. The method is evaluated. During summer, pH and phosphate concentrations increased in the upper 8-10 cm of the sediment. Increased pH was most pronounced in the upper 5 cm, where pH increased to between 9 and 10. This is believed to be caused by the photosynthetically elevated pH in the above lake water. Phosphate concentrations increased with depth, from 0-2 mg P/L in the upper 5 cm to 3-6 mg P/L in 6-10 cm depth. Average phosphate gradient in the upper 6-8 cm was 1.0 mg P/L/cm in the summer decreasing to 0.2 mg P/L/cm in the autumn/winter. In spite of low redox potential, Fe(II) was not present in the upper 20 cm. The seasonal variation in pore water is believed to be due to the variations in pore water pH inducing a substitution of phosphate ions with hydroxyl ions on iron-hydroxides during summer. A considerable sedimentation of organic bound phosphorus and decomposition in the sediment is also considered important. Phosphorus release from the sediment is facilitated by bio-turbation and gas turbation and by the frequent occurrence of resuspension caused by wind action. Net release rate is highly variable during the season. The summer average is 40 mg P/sq m/d. (Author's abstract)
W90-08317

DISTRIBUTION OF IRON IN LAKE BANYOLES IN RELATION TO THE ECOLOGY OF PURPLE AND GREEN SULFUR BACTERIA.
Institut d'Ecologia Aquatica, Gerona (Spain).
L. J. Garcia-Gil, L. Sala-Genoher, J. V. Esteva, and C. A. Abella.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 259-270, March 15, 1990. 12 fig, 3 tab, 24 ref.

Descriptors: *Iron, *Lake Banyoles, *Limnology, *Sulfur bacteria, Biochemistry, Chemical interactions, Ferrous sulfide, Interstitial water, Oxidation-reduction potential, Oxygen, Spain, Suspended sediments.

The distribution of iron both in suspended sediment and in the water column has been studied during summer stratification in Lake Banyoles, Spain. In this lake, near the bottom springs, a very fine 'suspended sediment' remains in suspension. Dissolved Fe(2+) in the interstitial water of this suspended sediment, is related to redox potential and to the bottom water inflow. In the water column, soluble iron is present in the hypolimnion of the six different basins forming Lake Banyoles. Under those conditions Fe(2+) is partially removed by sulfide produced in the anoxic sediment. In addition, a peak of Fe(2+) was found at the density gradient level in three basins. A three compartment model on the dynamics of the processes involving iron in Lake Banyoles was proposed. The bottom springs supply oxygen to the anoxic hypolimnion affecting chemical processes of the iron cycle. The presence of phototrophic sulfur bacteria in the anoxic monimolimnion of two of the basins can be related to the kinetics of Fe(2+) and sulfide. In the third basin, sulfide concentrations exceed Fe(2+). The presence of phototrophic sulfur bacteria in iron-containing environments with no detectable sulfide is explained by the ability of such microorganisms to use FeS as an electron donor instead of H2S. (Author's abstract)
W90-08318

DETERMINATION OF AVAILABLE PHOSPHORUS FOR PHYTOPLANKTON POPULA-

TIONS IN LAKES AND RIVERS OF SOUTHEASTERN NORWAY.
Direktoratet for Vilt og Ferskvannsfisk, Trondheim (Norway).
I. Blakar, and O. Lovstad.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 271-277, March 15, 1990. 5 fig, 3 tab, 16 ref.

Descriptors: *Bioassay, *Norway, *Phosphorus, *Phytoplankton, Algae, Biological studies, Filters, Laboratory methods, Lakes, River Romua, Rivers, Seasonal variation, Seston.

A biotest method with diluted phytoplankton populations was used to determine external concentrations of available phosphorus in water samples with high concentrations of inorganic seston from River Romua. RP (total molybdate reactive P measured on unfiltered samples) was approximately the P fraction available for Synedra cf. acus, Asterionella formosa and Oscillatoria agardhii. In filtered samples RPF (reactive P measured on filtered sample) was the available concentration of P. The algal availability of P may often vary between 25 and 75% of total phosphorus (TP) if the concentration of inorganic seston is high. At high RP:RPF ratios biotest experiments with filtered water samples may give erroneous results. The ratio RP:RPF is highest (often > 5) in periods with high external supply rates of inorganic seston, especially in spring and autumn. High resuspension of sediments may also result in high RP:RPF ratios. Frequently, however, the ratio varies between 1 and 2 during the summer (June-August). In samples from most of the lakes the ratio RP:RPF = 1 during this period. At low concentrations of inorganic seston RPF is often equivalent with RP and is also often independent on the filter types used. (Author's abstract)
W90-08319

HYDROCHEMICAL PROCESSES IN GROUNDWATER-DISCHARGE PLAYAS, CENTRAL AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 2K.
W90-08328

HYDRAULIC DESIGN OF WINTER LAKE AERATION SYSTEM.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 5G.
W90-08350

CALCULATION OF DAILY AVERAGE PHOTOSYNTHESIS.
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
M. T. Auer, and S. W. Effler.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 412-418, March/April 1990. 3 fig, 10 ref.

Descriptors: *Aquatic productivity, *Dissolved oxygen, *Mathematical models, *Model studies, *Photosynthesis, Light penetration, Organic carbon, Oxygenation, Plankton, Solar radiation.

Estimation of photosynthetic production is a fundamental component in the development of mathematical models for dissolved oxygen, organic carbon, and plankton dynamics. Photosynthetic production is regulated in part by the amount of photosynthetically available radiation (PAR: 400-700 nm) present. This dependence is specified by a photosynthesis-light (P-I) curve. It has been stressed that integration of photosynthesis over both time and depth is required for accurate estimates of photosynthetic rates. Systematic errors in estimates of daily average rates result when certain time-averaging and depth-averaging techniques are used. Three methods exist for calculating daily average net photosynthetic oxygen production in the water column, each requiring quantification of the PAR, identification of an appropriate relationship between PAR and the rate of photosynthesis (P-I curve), and selection of a technique for inte-

grating the rate of photosynthesis over time and depth. The results are intended to provide modelers guidance in selecting a particular approach. (Author's abstract)
W90-08352

EFFECTS OF DECREASING HEAVY METAL CONCENTRATIONS ON THE BIOTA OF BUTTLE LAKE, VANCOUVER ISLAND, BRITISH COLUMBIA.
Ministry of Environment, Nanaimo (British Columbia). Waste Management Branch.
For primary bibliographic entry see Field 5G.
W90-08381

MEASUREMENT OF ELECTRON TRANSPORT SYSTEM ACTIVITY IN RIVER BIOFILMS.
University Coll. of North Wales, Bangor. School of Biological Sciences.
For primary bibliographic entry see Field 7B.
W90-08385

ACID STRESS AND AQUATIC MICROBIAL INTERACTIONS.
For primary bibliographic entry see Field 5C.
W90-08414

MICROBES, SEDIMENTS, AND ACIDIFIED WATER: THE IMPORTANCE OF BIOLOGICAL BUFFERING.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-08415

BIOGEOCHEMICAL CYCLING OF ORGANIC MATTER IN ACIDIC ENVIRONMENTS: ARE MICROBIAL DEGRADATIVE PROCESSES ADAPTED TO LOW PH.
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5C.
W90-08417

MICROBIAL BIOGEOCHEMICAL PROCESSES IN A NATURALLY ACIDIC WETLAND, THE OKEFENOKEE SWAMP.
Georgia Univ., Athens. Dept. of Microbiology.
R. E. Hodson, M. A. Moran, D. L. Lewis, R. Murray, and J. D. Teska.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 47-58, 3 fig, 3 tab, 28 ref. NSF Grants BSR 8215587 and BSR 8114823.

Descriptors: *Acid rain effects, *Acidic water, *Microorganisms, *Okefenokee Swamp, *Path of pollutants, *Water pollution effects, *Wetlands, Bacteria, Biochemistry, Biodegradation, Detritus, Ecological effects, Florida, Hydrogen ion concentration, Lignin, Microbiological studies, Mineralization, Organic matter, Swamps.

Contrary to assumptions made by early Okefenokee investigators, this highly acidic wetland does support abundant and active microbial populations relative even to the most microbiologically rich ecosystems previously studied. The microorganisms rapidly utilize simple dissolved organic compounds and support high rates of secondary production of particulate organic carbon (biomass). No conclusive evidence of reduction in rates of these processes due to the acidic conditions in the Swamp has been observed. In contrast, bacterial isolates from the Okefenokee grow well under rich laboratory conditions at pH 7 but not at the in situ pH 4. Microorganisms, principally bacteria, are active also in the mineralization of refractory lignocellulosic detritus derived from vascular plants. However, rates of this process appear to be reduced twofold or more by the acidity of the Okefenokee relative to rates in neutral-pH wetland environments. The reduction in lignocellulose mineralization rates is consistent with, but not necessarily a major contributing factor in, the significant accumulation of organic matter as peat in the Okefenokee. Moreover, the rates of conversion of refracto-

ry detrital lignocellulose to microbial biomass appear to be insufficient to consider carbon flow from lignocellulose to bacteria to bacterivorous animals to be the major link between primary and secondary production in this ecosystem. Rather it is assumed, based on available data, that other, perhaps pH-insensitive carbon flow pathways are equally or more important. (See also W90-08414) (Lantz-PTT)
W90-08418

SULFUR BIOGEOCHEMISTRY OF AN ACIDIC LAKE IN THE ADIRONDACK REGION OF NEW YORK.
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse. Dept. of Environmental and Forest Biology.
For primary bibliographic entry see Field 5B.
W90-08419

EPILITHIC MICROBIAL POPULATIONS AND LEAF DECOMPOSITION IN ACID-STRESSED STREAMS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W90-08420

ALGAL ASSEMBLAGES IN ACID-STRESSED LAKES WITH PARTICULAR EMPHASIS ON DIATOMS AND CHRYSOPHYTES.
Queen's Univ., Kingston (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W90-08421

DIATOM STRATIGRAPHY IN ACID-STRESSED LAKES IN THE NETHERLANDS, CANADA, AND CHINA.
Brock Univ., St. Catharines (Ontario). Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W90-08422

PROTOZOAN BACTERIVORY IN ACIDIFIED WATERS: METHODS OF ANALYSIS AND THE EFFECT OF PH.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5C.
W90-08423

SEQUENTIAL ANAEROBIC DEGRADATION OF 2,4-DICHLOROPHEND IN FRESHWATER SEDIMENTS.
Georgia Univ., Athens. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W90-08428

CHAROPHYTE GERMINATION AND ESTABLISHMENT FROM THE SEED BANK OF AN AUSTRALIAN TEMPORARY LAKE.
University of New England, Armidale (Australia). Dept. of Botany.
M. T. Casanova, and M. A. Brock.
Aquatic Botany AQBODS, Vol. 36, No. 3, p 247-254, March 1990. 2 fig, 1 tab, 15 ref. Australian Research Grant D1851718.

Descriptors: *Aquatic plants, *Chara, *Ephemeral lakes, *Germination, *Lakes, *Limnology, *Seeds, *Submerged plants, Australia, Comparison studies.

The charophytes Chara corallina and Nitella subtilissima are present in temporary wetlands in Australia. The mean maximum percentage germination of these two species and the number of oospores in the seed bank were compared using germination and total count methods of seed bank analysis. The pattern of germination in both field and laboratory studies and the fate of individual sporelings of both species was examined. C. corallina showed a pattern of later germination of 5% of the seed bank, a high rate of establishment and early reproduction, whereas N. subtilissima had earlier 13% germination, poor establishment and did not reproduce during the experimental period. (Author's abstract)

W90-08430

SEASONAL GROWTH OF PISTIA STRATIOTES L. IN SOUTH FLORIDA.
Florida Medical Entomology Lab., Vero Beach.
L. B. Dewald, and L. P. Lounibos.
Aquatic Botany AQBODS, Vol. 36, No. 3, p 263-275, March 1990. 6 fig, 1 tab, 14 ref. U.S. Army Contract DAMD17-85-C-5182.

Descriptors: *Floating plants, *Florida, *Limnology, *Plant growth, *Seasonal variation, Aquatic plants, Biomass, Leaves, Roots, Temperature.

Two populations of Pistia stratiotes in an unused aquaculture pond and a roadside drainage ditch were sampled monthly for 1.5 years to examine seasonal trends in leaf area, leaf and plant densities, leaf and root biomasses, and flowering. Biomasses and leaf areas were sharply depressed by winter cold, especially by subfreezing temperatures. Spring regrowth occurred by budding and the proliferation of small plants. From late spring through mid-summer, leaf size and plant biomass increased and plant density decreased; these variables did not change markedly between August and December. In both populations, flowering occurred synchronously during December, but no sexual reproduction was observed. Winter cold is a major determinant of growth patterns in south Florida, but local conditions are also important. Measurements from the day of unfurling until subsidence into the water showed that leaves reached an average length of 15.3 cm after 2 weeks and declined towards the water at a rate of 2.9 degrees/day. (Author's abstract)
W90-08431

SURVIVAL AND DEVELOPMENT OF LAKE TROUT (SALVELINUS NAMAYCUSH) EMBRYOS IN AN ACIDIFIED LAKE IN NORTHWESTERN ONTARIO.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5C.
W90-08432

EFFECT OF NUTRIENT ADDITIONS ON LOWER TROPHIC LEVELS OF AN OLIGOTROPHIC LAKE WITH A SEASONAL DEEP CHLOROPHYLL MAXIMUM.
Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.
K. S. Shortreed, and J. G. Stockner.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 262-273, February 1990. 10 fig, 2 tab, 36 ref.

Descriptors: *Limnology, *Nutrients, *Oligotrophic lakes, *Phytoplankton, *Trophic level, Aquatic bacteria, British Columbia, Canada, Chlorophyll, Cyanophyta, Diatoms, Nitrogen, Phosphorus, Photosynthesis, Population density, Seasonal variation, Species composition, Sproat lake, Vancouver Island, Water chemistry.

Inorganic N and P were added to the surface of selected areas of Sproat Lake, Vancouver Island, British Columbia for varying periods in 1985 and 1986. The lake is monomictic, oligotrophic, and for much of each year has a deep chlorophyll maximum (DCM) located near the bottom of the euphotic zone (20-25 m). Epilimnetic chlorophyll concentrations are low (0.5 micrograms/L) in summer, and DCM concentrations are from 3-10 times higher. The diatom Rhizosolenia eriensis was a dominant species in the epilimnion in spring and at the DCM for much of the year, but was rare in the epilimnion during the summer, and consequently was not affected by the nutrient additions. Cyclotella spp. was also abundant in spring, were a prominent component of the DCM, and increased in abundance during nutrient additions. The cyanobacterium Synechococcus was the dominant member of the autotrophic picoplankton community and during the nutrient additions densities reached 300,000/mL (a 10-fold increase). Bacterioplankton numbers also increased during nutrient additions, at times exceeding 3,000,000/mL. The

DCM was formed and maintained by sinking cells, by occasional active photosynthesis at the DCM, and by an increase in chlorophyll/cell. (Author's abstract)
W90-08433

PATTERNS IN THE SUBMERGED MACRO-PHYTE BIOMASS OF LAKES AND THE IMPORTANCE OF THE SCALE OF ANALYSIS IN THE INTERPRETATION.
McGill Univ., Montreal (Quebec). Dept. of Biology.
C. M. Duarte, and J. Kalff.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 357-363, February 1990. 5 fig, 2 tab, 39 ref.

Descriptors: *Lakes, *Limnology, *Submerged plants, Alkalinity, Biomass, Chlorophyll a, Light intensity, Littoral zone, Phosphorus, Physical properties, Transparency, Water chemistry, Waves.

The relative contributions of lake characteristics (i.e. alkalinity, chlorophyll a concentration, total P concentration, conductivity, and morphometry) and site characteristics (i.e. depth, littoral slope, exposure to waves, and underwater light levels) to the variability in submerged biomass were examined in 25 Canadian and American lakes. Lake-average submerged biomass is a function of water alkalinity and the lake-average littoral slope, whereas site-specific biomass is a function of both site and lake characteristics. Plant biomass decreased with increasing slope and wave exposure and increased with increasing alkalinity and light levels. However, these relationships are complex because submerged biomass is also influenced by threshold phenomena (e.g. critical littoral slopes and transparency-dependent critical depths) that set limits to macrophyte colonization and because the relative contributions of the most relevant environmental factors studied (i.e. littoral slope, exposure, water transparency, and alkalinity) are depth dependent. By demonstrating the importance of lake-average and site-specific scales of variation and the existence of noncontinuous (e.g. threshold) regulation mechanisms the findings provide a new conceptual framework for the study of the relationship between submerged macrophytes and their associated biota as well as their environment. (Author's abstract)
W90-08435

RELATIVE IMPORTANCE OF PHOSPHORUS SUPPLY TO PHYTOPLANKTON PRODUCTION: FISH EXCRETION VERSUS EXTERNAL LOADING.
Oslo Univ. (Norway). Zoological Museum.
A. Braband, B. A. Faafeng, and J. P. M. Nilssen.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 364-372, February 1990. 4 fig, 38 ref.

Descriptors: *Algae, *Cycling nutrients, *Eutrophication, *Fish, *Limnology, *Phosphorus, *Phytoplankton, Ammonium, Aquatic biology, Bream, Lake Gjersjoen, Lake sediments, Lakes, Nitrogen, Norway, Perch, Roach, Tributaries.

In laboratory tanks with bream (Abramis brama), perch (Perca fluviatilis), and roach (Rutilus rutilus), concentrations of P and N increased with time. P was mainly released as soluble molybdate-reactive P; N almost exclusively as ammonium. The release increased with the species' tendency to forage on littoral sediments and with a smaller fish size. Bioassays with the test algae Selenastrum capricornutum showed that released P was readily available to algal growth. The total supply of P to the epilimnion of Lake Gjersjoen was calculated from the external supply from the tributaries and the estimated P release from the total roach biomass. From May to October 1980 P release from the roach population contributed about the same order of magnitude as the total P loading from the watershed. During the period with the most serious P depletion to the phytoplankton (July, August, and September), the P supply from fish was about double that of the external P supply, confirming the important role of sediment-feeding

fish populations in the eutrophication processes of lakes. (Author's abstract)
W90-08436

LONGITUDINAL STRUCTURE OF AN AGRICULTURAL PRAIRIE RIVER SYSTEM AND ITS RELATIONSHIP TO CURRENT STREAM ECOSYSTEM THEORY.
Michigan Univ., Ann Arbor. School of Natural Resources.
M. J. Wiley, L. L. Osborne, and R. W. Larimore.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 373-384, February 1990. 6 fig, 8 tab, 44 ref.

Descriptors: *Agricultural watersheds, *Ecosystems, *Land use, *Prairies, *Primary productivity, *River systems, *Urbanization, Illinois, Light intensity, Nitrates, Nutrients, Orthophosphates, Physical properties, Riparian vegetation, Turbidity, Water chemistry, Water temperature.

The large-scale structure of an agriculturally developed prairie river system in central Illinois was examined and compared with predictions from current stream ecosystem theory. High rates of primary productivity (>15 g carbon/sq m/d) were characteristic of the watershed, although longitudinal patterns in riparian vegetation, stream temperature, and primary productivity were inverted relative to typical streams in forested uplands. Empirical models of gross primary production and community respiration were developed. Light availability, mediated by both channel shading and turbidity, appeared to be the principal factor limiting primary productivity. Both nitrate and orthophosphorus were found in high concentrations throughout the watershed. Large-scale patterns in nutrient availability suggest that land use patterns, and particularly urbanization, strongly affected spatial and temporal distributions of both nutrients. Differences between prairie river systems and 'prototype' structures envisioned by the River Continuum Concept (RCC) derive from the descriptive nature of the RCC, and its inability to incorporate nonstandard distributions of key driving variables. (Author's abstract)
W90-08437

COMPARATIVE POPULATION DYNAMICS OF DAPHNIA ROSEA AND HOLOPEDIUM GIBBERUM IN FOUR OLIGOTROPHIC LAKES.
British Columbia Univ., Vancouver. Inst. of Animal Resource Ecology.
C. J. Walters, D. C. E. Robinson, and T. G. Northcote.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 401-409, February 1990. 11 fig, 1 tab, 31 ref.

Descriptors: *Daphnia, *Limnology, *Oligotrophic lakes, *Plankton, *Population dynamics, *Waterfleas, British Columbia, Canada, Comparison studies, Ecosystems, Mortality, Seasonal variation, Water temperature.

Seasonal abundance patterns of Daphnia rosea and Holopedium gibberum showed great variability over the period 1974-83 in four coastal montane lakes of British Columbia. Though the lakes differed considerably in size, depth, and history of experimental disturbance (fish introductions, fertilization, plankton harvesting), these differences apparently had much less influence on seasonal abundance patterns than did interannual variation in environmental factors shared by all the lakes. Spring rates of population increase differed strongly among years and were positively correlated between the two species. The timing and magnitude of summer population maxima also differed significantly among years, but were not correlated between the species. Adult mortality rates tended to increase through each season for both species, but showed no clear correlations either between the species or between the years. Annual differences in growth and mortality rates and peak abundances were not associated with any obvious differences in environmental factors (insolation, rainfall, water temperature). There was no evidence of direct competition between the species, in terms of

negative correlations in abundance. This is surprising in view of their similar life histories and feeding ecologies. (Author's abstract)
W90-08438

WHOLE-LAKE AND NEARSHORE WATER CHEMISTRY IN BOWLAND LAKE, BEFORE AND AFTER TREATMENT WITH CACO3.
B.A.R. Environmental, Guelph (Ontario).
For primary bibliographic entry see Field 5G.
W90-08439

RESPONSE OF PHYTOPLANKTON IN ACIDIC LAKES IN ONTARIO TO WHOLE-LAKE NEUTRALIZATION.
B.A.R. Environmental, Guelph (Ontario).
For primary bibliographic entry see Field 5G.
W90-08440

EFFECTS OF NEUTRALIZATION AND EARLY REACIDIFICATION ON FILAMENTOUS ALGAE AND MACROPHYTES IN BOWLAND LAKE.
Ontario Ministry of the Environment, Rexdale. Aquatic Biology Section.
For primary bibliographic entry see Field 5G.
W90-08441

CHANGES IN THE ZOOBENTHOS COMMUNITY OF ACIDIFIED BOWLAND LAKE AFTER WHOLE-LAKE NEUTRALIZATION AND LAKE TROUT (SALVELINUS NAMAYCUSH) REINTRODUCTION.
Ontario Ministry of the Environment, Sudbury.
For primary bibliographic entry see Field 5G.
W90-08442

SURVIVAL, GROWTH, AND REPRODUCTION OF LAKE TROUT (SALVELINUS NAMAYCUSH) AND YELLOW PERCH (PERCA FLAVESCENS) AFTER NEUTRALIZATION OF AN ACIDIC LAKE NEAR SUDBURY, ONTARIO.
Ontario Ministry of Natural Resources, Toronto. Fisheries Branch.
For primary bibliographic entry see Field 5G.
W90-08443

EFFECTS OF AMBIENT LAKE MOHAVE TEMPERATURES ON DEVELOPMENT, OXYGEN CONSUMPTION, AND HATCHING SUCCESS OF THE RAZORBACK SUCKER.
Nevada Univ., Las Vegas. Lake Mead Limnological Research Center.
M. A. Bozek, L. J. Paulson, and G. R. Wilde.
Environmental Biology of Fishes EBFID3, Vol. 27, No. 4, p 255-263, April 1990. 1 fig, 3 tab, 39 ref.

Descriptors: *Arizona, *Dam effects, *Fish, *Hatching, *Lake Mohave, *Larvae, *Oxygen requirements, *Spawning, *Sucker, *Temperature effects, *Water temperature, Nevada.

Spawning of razorback suckers, Xyrauchen texanus, in Lake Mohave occurred from 10-22 C and larvae were collected at water temperatures from 10-15 C in 1982 and 1983. In the laboratory, hatching success was similar from 12-20 C, but reduced hatching success was found at 10 C while none hatched at 8 C. Development rate and oxygen consumption were positively related to incubation temperature. Direct effects of ambient Lake Mohave water temperatures on hatching success of razorback sucker embryos are considered minimal. Historical spawning temperatures for the species are hypothesized based upon successful incubation temperatures and comparison to the white sucker, Catostomus commersoni. (Author's abstract)
W90-08457

DELAYED SPAWNING OF PERCH, PERCA FLUVIATILIS L., IN ACIDIFIED LAKES.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
M. Rask, P. J. Vuorinen, and M. Vuorinen.

Group 2H—Lakes

Journal of Fish Biology JFIBA9, Vol. 36, No. 3, p 317-325, March 1990. 5 fig, 1 tab, 33 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Acidification, *Fish physiology, *Perch, *Spawning, *Water pollution effects, Finland, Growth, Hydrogen ion concentration, Water temperature.

Acidification of lakes through increased S and N emissions is known to produce losses of fish populations. The timing of spawning of perch was examined in four acidified lakes (pH 4.4-4.8) and in one circum-neutral lake (pH 6.3) in southern Finland in spring 1987. In three of the lakes, perch started to spawn soon after the ice melt (4-14 degree days >5 C) and had spawned by the end of May at about 100 degree days >5 C. In the two most acidified lakes, fish started to spawn later, at 35 and 60 degree days >5 C, and had spawned in early June, at about 200 degree days >5 C. The maturing of gonadal products was delayed in both males and females. (Author's abstract)
W90-08461

DISTRIBUTION OF FINGERLING BROOK TROUT, SALVELINUS FONTINALIS (MITCHILL), IN DISSOLVED OXYGEN CONCENTRATION GRADIENTS.
Environmental Research Lab.-Duluth, MN.
W. A. Spoor.
Journal of Fish Biology JFIBA9, Vol. 36, No. 3, p 363-373, March 1990. 3 fig, 5 tab, 28 ref.

Descriptors: *Dissolved oxygen, *Fish behavior, *Oxygen, *Trout.

A self-recording linear gradient tank and procedures were used in which individual brook trout fingerlings unstressed by recent transfer, unaccustomed surrounding or the presence of an observer could move freely in 16 oxygen concentration gradients within the limits of 1 and 8.9 mg oxygen/L. The fish avoided oxygen concentrations below 4 mg/L most of the time and preferred 5 mg/L or higher more than half the time, which supports the field-derived belief that fish avoid oxygen concentrations below 5 mg/L in the natural environment if they can. (Author's abstract)
W90-08463

MOVEMENTS OF CHANNEL AND FLATLAND CATFISH BETWEEN THE MISSOURI RIVER AND A TRIBUTARY, PERCHE CREEK.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
For primary bibliographic entry see Field 4C.
W90-08467

EFFECT OF CLIMATE CHANGE ON EVAPORATION AND WATER TEMPERATURE.
Institute of Meteorology and Water Management, Warsaw (Poland).
For primary bibliographic entry see Field 2B.
W90-08573

CLIMATE AND LAKES.
Leningrad Hydrometeorological Inst. (USSR).
A. M. Doganovsky.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 392-401, 2 fig, 8 ref.

Descriptors: *Climatic changes, *Climatology, *Global warming, *Lakes, *Limnology, *Water level fluctuations, Lake biota, Lake ecosystems, Lake morphometry, Mathematical equations.

Characteristics of long-term fluctuations of water levels in lakes of different types are considered depending on climate variations. The effect of level regime on the formation and functioning of lake ecosystems is shown. Water level fluctuations affect lake basin morphometry, dynamics of water resources, different processes in the lake, dissolved solids content, and bioproductivity. All these components and their dynamics determine to a great extent the component composition and functioning of ecosystems. Level fluctuations in water bodies

result from an equilibrium disturbance between input and outflow with variations of these components depending on the variations of climatic conditions. However, different lakes respond in different ways, which is displayed in the nature of level fluctuations. The structure of level series may be judged by the autocorrelation coefficient value, by autocorrelation function, and by spectrum analysis. The knowledge of the laws of level fluctuations makes it possible to use expert assessments to judge lake biota. The availability of cyclic lake level fluctuations of various periods with low-frequency components leads to qualitative changes of species and populations in general in the case of short-period fluctuations and to the changes in the quantitative composition of biota. A comparison of design and observed levels may also be useful for assessing anthropogenic changes of climate. (See also W90-08565) (White-Reimer-PTT)
W90-08594

THERMAL CHARACTERISTICS OF LAKES AS A MEASURE OF CLIMATE CHANGE.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
D. G. George.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 402-412, 5 fig, 15 ref.

Descriptors: *Climatic changes, *Climatology, *Global warming, *Lake morphometry, *Lakes, Air temperature, Atmospheric physics, England, Lake stratification, Regional variation, Seasonal variation, Thermal effects, Topography.

The thermal characteristics of a lake are determined by the interaction of fixed topographic and variable climatic factors. Each lake can thus be regarded as a recording climatic instrument capable of responding to quite subtle regional variations. A number of methods currently being used to study the spatial and temporal links between the physics of lakes and the atmosphere are reviewed. The seasonal variation in the surface temperature of many lakes can be predicted from latitudinal models of global radiance and cloud cover. The surface temperatures of some deep lakes deviate from this global trend if they are subject to intense wind mixing. A 40 year study of temperatures in Windermere showed that the early summer temperatures followed a definite 10 year cycle related to the timing of thermal stratification. A similar cycle in sea-surface temperatures has been recorded in the Celtic Sea. The correlation between physical events in Windermere and in the ocean almost certainly reflect a common response to some large-scale feature of the atmospheric circulation. (See also W90-08565) (Author's abstract)
W90-08595

ESTIMATION OF THE READILY OXIDIZABLE ORGANIC MATTER RESERVE AND ITS EFFECT ON THE INTENSITY OF ORGANIC MATTER DESTRUCTION BY BACTERIA IN THE DANUBE RIVER.
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
I. K. Bashmacova.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 31-33, 1990. 1 fig.

Descriptors: *Danube River, *Fate of pollutants, *Path of pollutants, *Pollution effects, Bacteria, Biodegradation, Ecosystems, Organic matter, Water quality control.

During an international expedition devoted to studying the Danube River, in March 1988, the influence of readily oxidizable organic matter on the destruction of organic matter by bacteria was investigated. Readily oxidizable (labile) organic matter (LOM), LOM turnover rate, and concentration of particulate organic matter (POM) were quantitatively analyzed. It was found that the minimum values of the parameters studied occurred in the Middle Danube, i.e., the Bulgarian and Yugoslavian stretches of the river. Self-purification did not exceed 23 days. Regarding the Upper Danube (i.e., Austria, Czechoslovakia, and Hungary),

higher LOM and POM concentrations, bacterial respiration intensity, and self-purification rates (15 days) were observed. However, the maximum values were found in the Kilia delta (USSR). This was attributed to the great amount of organic matter in particulates contributed from the upper reaches of the river. At the same time, the Soviet stretch of the Danube was characterized by the most intense processes of destruction of organic matter associated with aggregated bacterioplankton, which gave higher self-purification rates (up to 9 days). (Author's abstract)
W90-08607

2I. Water In Plants

SOIL PHYSICS.
Commonwealth Scientific and Industrial Research Organization, Adelaide (Australia). Div. of Soils.
For primary bibliographic entry see Field 2G.
W90-07555

EFFECTS OF DIFFERENT AMOUNTS OF WATER ON THE TOMATO CROP (LYCOPERSICON ESCULENTUM MILL.): II. EVAPOTRANSPIRATION-GROWTH-NUTRITION RELATIONSHIPS, (EFFECTOS DE DIFERENTES ALTURAS DE AGUA SOBRE EL CULTIVO DEL TOMATE (LYCOPERSICON ESCULENTUM MILL.) II. RELACION EVAPOTRANSPIRACION-CRECIMIENTO-NUTRICION).
Instituto de Investigaciones Agropecuarias, Santiago (Chile).
For primary bibliographic entry see Field 3F.
W90-07661

OPTIMAL CONTROL METHOD FOR REAL-TIME IRRIGATION SCHEDULING.
Georgia Inst. of Tech., Atlanta.
For primary bibliographic entry see Field 3F.
W90-07674

SULFUR, NITROGEN, AND PH LEVELS IN WISCONSIN PRECIPITATION.
Wisconsin Univ., Madison. Dept. of Soil Science.
For primary bibliographic entry see Field 5B.
W90-07700

NITRATE-NITROGEN CONCENTRATIONS IN PERCOLATE FROM LYSIMETERS PLANTED TO A LEGUME-GRASS MIXTURE.
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
For primary bibliographic entry see Field 5B.
W90-07707

CONTROL OF ARBORESCENT VEGETATION BELOW POWER LINES WITH WASTEWATER SLUDGE.
Quebec Ministere de l'Energie et des Ressources, Sainte-Foy. Service de la Recherche Appliquee.
For primary bibliographic entry see Field 5E.
W90-07708

GROWTH AND ELEMENTAL CONTENT OF SLASH PINE 16 YEARS AFTER TREATMENT WITH GARBAGE COMPOSTED WITH SEWAGE SLUDGE.
Florida Univ., Gainesville. Dept. of Forestry.
For primary bibliographic entry see Field 5E.
W90-07709

WATERSHED SCALE RAINFALL INTERCEPTION ON TWO FORESTED WATERSHEDS IN THE LUQUILLO MOUNTAINS OF PUERTO RICO.
Institute of Tropical Forestry, Rio Piedras, PR.
For primary bibliographic entry see Field 2E.
W90-07979

TOWARDS MONITORING DROUGHTS FROM SPACE.
Maryland Univ., College Park. Cooperative Inst.

for Climate Studies.
G. G. Gutman.
Journal of Climate JLCLEL, Vol. 3, No. 2, p 282-295, February 1990. 9 fig, 20 ref.

Descriptors: *Drought, *Remote sensing, *Satellite technology, *Soil surfaces, Soil water, *Soil-water-plant relationships, Palmer Drought Index, Radiometry, Temperature, Thermal radiation, Vegetation index.

Since vegetation can take up moisture from deep in the soil and remain vigorous until the root-zone moisture is exhausted, the observed changes in vegetation as manifested by vegetation indices can lag in time relative to the conditions described by meteorological indices. The utility of the midafternoon satellite-derived surface temperatures for detecting drought events was examined using the NOAA-9 AVHRR (Advanced Very High Resolution Radiometer) data over the U.S. Great Plains during 1986-88. The interannual differences in monthly mean clear-sky temperature and in monthly mean normalized difference vegetation index are compared to the corresponding differences in the Palmer Drought Index. Results indicate that the thermal data from polar orbiters may be very useful in detecting the interannual changes in surface moisture when the change in vegetation index fails to produce the significant signal. (Author's abstract)
W90-08005

EFFECT OF WATER STRESS ON THE CANOPY ARCHITECTURE AND SPECTRAL INDICES OF IRRIGATED ALFALFA.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 3F.
W90-08016

CORRELATIONS BETWEEN CANOPY REFLECTANCE AND LEAF TEMPERATURE IN IRRIGATED AND DROUGHTED SOYBEANS.
North Carolina State Univ. at Raleigh. Dept. of Forestry.
For primary bibliographic entry see Field 3F.
W90-08017

CALCULATION OF DAILY AVERAGE PHOTOSYNTHESIS.
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W90-08352

PHYSIOLOGICAL RESPONSES OF TWO SOYBEAN (GLYCINE MAX (L.) MERR.) CULTIVARS TO SHORT-TERM FLOODING.
Arkansas Univ., Fayetteville. Dept. of Agronomy.
For primary bibliographic entry see Field 3F.
W90-08459

RESPONSE OF FOUR BRASSICA SPECIES TO DROUGHT STRESS.
Bahauddin Zakariya Univ., Multan (Pakistan). Inst. of Pure and Applied Biology.
M. Ashraf, and S. Mehmood.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 1, p 93-100, January 1990. 1 fig, 4 tab, 23 ref.

Descriptors: *Drought resistance, *Oilseed crops, *Plant physiology, Biomass, Brassica, Chlorophyll, Leaves, Osmotic potential, Proteins, Roots, Shoots.

The relative drought tolerance of four Brassica species, B. campestris (sarson), B. carinata (Ethiopian mustard), B. juncea (brown mustard), and B. napus (oilseed rape) was assessed after having subjected them to repeated drought cycles for 24 days. There was a close relationship between biomass production and water content, and water relations of all four species in response to repeated drought cycles. B. carinata produced significantly lower fresh and dry biomasses and had less water content, wax on leaf surface, and total protein

content in shoots and roots, but had a higher leaf water potential at wilting and osmotic potential after rehydration than the other species. By contrast B. napus produced relatively greater fresh and dry biomass and had higher water content, chlorophyll and protein content in shoots and roots, but had lower leaf water and osmotic potentials. The results indicate that B. napus was the most drought tolerant, B. juncea and B. campestris intermediate, and B. carinata the most sensitive to drought stress. The data support the postulate that osmotic adjustment is a probable component of drought tolerance in these species. (Author's abstract)
W90-08460

POSSIBLE CHANGES IN FOREST HYDROLOGY FOLLOWING A GLOBAL CLIMATIC CHANGE.
Groningen Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
H. J. M. Lankreyer, and A. W. L. Veen.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 187-196, 4 fig, 2 tab, 21 ref.

Descriptors: *Climatic changes, *Evaporation, *Forest hydrology, *Model studies, *Transpiration, Biomass, Humidity, Meteorological data, Model testing, Parameterization, Rainfall, Runoff, Sensitivity analysis, Stomatal behavior.

The parameterization of forest evapotranspiration—as incorporated in a one-dimensional model, based on the Penman-Monteith equation—is applied to analyze interaction mechanisms in evaporation. The results are presented for a sensitivity study based on meteorological data, and changed forest parameters. It was found that higher rainfall and lower stomatal conductance will cause a significant increase of water drainage from the forest soil. Advantages of the model are the feedback mechanisms of surface conductance on environmental conditions, and the time step of one hour in the transpiration calculations. The real problem is in the detail of climatic change. If the projected changes in rainfall, humidity, needle mass and stomatal behavior are reasonable, then the amounts of excess water draining annually from forest soil will increase significantly. This increase is largely due to the combined effect of higher rainfall and lower stomatal conductance. However, feedback on the conditions in the planetary boundary layer is lacking. Also the interception module has limited flexibility; it should be replaced by a more suitable module. (See also W90-08565) (Author's abstract)
W90-08578

MONITORING OF VEGETATION PERIOD COURSE OF SOIL MOISTURE BASED ON MEASUREMENTS AND EVALUATION IN HUNGARY.
Kozponti Meteorologiai Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2G.
W90-08584

IMPACT OF CLIMATE CHANGE ON GROUNDWATER RECHARGE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2F.
W90-08604

2J. Erosion and Sedimentation

CONICAL KARST: ITS ORIGIN FROM THE EXAMPLE OF THE SOUTH CHINA KARST (LE KARST CONIQUE: SA GENESE A PARTIR DE L'EXEMPLE DU KARST DU SUD DE LA CHINE).
Centre National de la Recherche Scientifique, Moulis (France). Lab. Souterrain.
For primary bibliographic entry see Field 2F.
W90-07567

MORPHOLOGICAL AND HYDROLOGICAL CHARACTERISTICS OF SOME ALLOCHTHONOUS RIVER CHANNELS, WESTERN DECCAN TRAP UPLAND REGION, INDIA.
Poona Univ. (India). Dept. of Geography.
V. S. Kale.
Geomorphology GEMPEZ, Vol. 3, No. 1, p 31-43, January 1990. 8 fig, 5 tab, 26 ref.

Descriptors: *Channel morphology, *Flood channels, *India, *Monsoons, *Sediment transport, Alluvial deposits, Alluvial rivers, Catchment basins, Drainage patterns, Hydraulic gradient, Sediment discharge, Sedimentary basins, Semiarid lands, Statistical analysis, Western Deccan Trap Upland Region.

Relations are established between various channel morphologic variables for the Upland rivers of Western Deccan Trap region, using seventy-three sites, three channel categories and ten parameters. The level of explained variance differed for three categories. The link between bankfull width and upstream length and between gradient and upstream length suggests a general consistency of downstream adjustment. Observations indicate that there is a large variation in form ratio, sinuosity, and bed material size, which cannot be statistically related to any of the measured morphologic variables. An attempt to relate morphologic variables to discharge, using limited data, reveals that the maximum monsoon discharge has a very strong influence on the channel width and gradient, rather than the mean monsoon discharge. The scatter in the data has been attributed to the allochthonous nature of the drainage, tributary influence, perimeter lithology and to the geomorphic history of the area. (Author's abstract)
W90-07571

LATE CENOZOIC EVOLUTION OF THE TUOLUMNE RIVER, CENTRAL SIERRA NEVADA, CALIFORNIA.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2E.
W90-07597

LOADING FUNCTIONS FOR PESTICIDE RUNOFF.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-07622

ADVANCES IN FLUVIAL GEOMORPHOLOGY OF MOUNTAIN ENVIRONMENTS.
Instituto Pirenaico de Ecologia, Jaca (Spain).
R. Martinez-Castroviejo.
Pirineos: Revista de Ecologia de Montana PRNOAJ, No. 132, p 65-88, July/December 1989. 99 ref.

Descriptors: *Bed load, *Channel morphology, *Fluvial sediments, *Geomorphology, *Sediment transport, Hydraulic properties, Sediment discharge, Sediment erosion, Sediment grading, Sediment sorting, Sediment-carrying capacity.

Rivers are the main sediment transport agent on the continental areas of the earth. The most recent evolution of the main trends in fluvial geomorphology was analyzed. In mountain areas, there are four interesting subjects: (1) bed load transport, especially its quantification and the mechanisms and processes that control it; (2) the bedforms in the stream channels, emphasizing the disturbances that their existence implies in the channel dynamics; (3) the sediment sources, whose supply determines to a great extent the pattern that channel shall adopt; (4) the adjustments that the river asserts itself as a response to changes, promoted or natural, produced both in the hydraulic parameters and in the sediment supply. The wide range of sediment size, variable sediment sources, and the difficulty of collecting reliable field data have prevented field verification of theoretical equations derived from flume experiments. Several recent studies have focussed on evaluating the effect of a bimodal distribution of the bed material, particular-

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ly the formation of an armor layer. Bedform research has examined the armor layer, as well as evaluating the hydraulic effect of the step-riffle-pool sequence. Recent sediment sources research has been concentrated on developing sediment budgets, in which streambank erosion is usually the most important process. Research into channel responses have focussed on dam construction, changes in land use, and flood events, all of which result from human activity. (Tappert-PTT)
W90-07632

GRAIN SIZE PARTITIONING OF METALS IN CONTAMINATED, COARSE-GRAINED RIVER FLOODPLAIN SEDIMENT: CLARK FORK RIVER, MONTANA, U.S.A.
Montana Univ., Missoula. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W90-07657

INSTABILITY OF HYDRAULIC GEOMETRY.
East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
J. D. Phillips.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 739-744, April 1990. 1 fig, 1 tab, 25 ref.

Descriptors: *Alluvial channels, *Channel flow, *Channel morphology, *Hydraulic geometry, *Sediment transport, *Stream profiles, Darcy-Weisbach equation, Model studies, Perturbations.

At-a-station hydraulic geometry of stream channels has been explained with varying degrees of success by several different theoretical approaches. However, observed variability in hydraulic geometry relations and theoretical shortcomings in existing approaches indicate that a satisfactory generally applicable model is lacking. The problem is approached by a qualitative asymptotic stability analysis of an equation system based on the Darcy-Weisbach flow resistance equation. No unique quantitative solution exists for the general case, but results show that the system is unstable. A change or perturbation in one or more system components (hydraulic radius, velocity, slope, resistance) will result in a new equilibrium condition, rather than restoration of the pre-disturbance condition. Even small changes in the channel are likely to result in new combinations of the flow variables. It is thus not surprising that at-a-station hydraulic geometry is quite variable, and that a satisfactory generally-applicable model has not been found. (Author's abstract)
W90-07681

LAKE LEVEL INFLUENCES ON SEDIMENT AND NUTRIENT RETENTION IN A LAKE-SIDE WETLAND.
Vermont Univ., Burlington. School of Natural Resources.
For primary bibliographic entry see Field 2H.
W90-07701

EFFECTS OF ESTUARINE INFAUNA ON SEDIMENT STABILITY AND PARTICLE SEDIMENTATION.
Glasgow Univ. (Scotland). Dept. of Zoology.
P. S. Meadows, J. Tait, and S. A. Hussain.
Hydrobiologia HYDRB8, Vol. 190, No. 3, p 263-266, February 15, 1990. 3 fig, 1 tab, 21 ref. University of Glasgow N.E.R.C. grant GT4/80/ALS/9.

Descriptors: *Benthic fauna, *Estuarine sediments, *Marine sediments, *Polychaetes, *Sediment stabilization, *Sediment transport, *Sedimentation, Erosion, Suspended sediments.

Secretions produced by the two estuarine benthic invertebrates Corophium volutator and Nereis diversicolor stabilize sediments by increasing their shear strength, and reduce sedimentation of previously resuspended particles. The secretions consist of 1 to 2 microm threads which bind the particles together. They are used by both species in the production of complex burrow systems in the top 15 cm of sediment. The burrow systems have been demonstrated by a new resin impregnation technique. The results suggest that bioturbation activi-

ty of C. volutator and N. diversicolor will increase the stability of sediments under field conditions and presumably increase their resistance to erosion. However, it appears that once resuspended, these particles will be carried further. The results have widespread implications for stability and erosion of sediments, particularly in relation to estuarine and near-shore environments where wave action is often heavy and currents rapid. (Author's abstract)
W90-07720

SCHEDULING MAINTENANCE DREDGING ON A SINGLE REACH WITH UNCERTAINTY.
California Univ., Berkeley. Dept. of Civil Engineering.
J. R. Lund.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 116, No. 2, p 211-231, March/April 1990. 7 fig, 2 tab, 23 ref.

Descriptors: *Dredging, *Economic aspects, *Maintenance dredging, *Navigation channels, Erosion, Probability studies, Risk analysis, Scheduling, Sedimentation rates.

New methods are suggested for scheduling advance maintenance dredging on isolated reaches of navigation channels based on economic and reliability analysis. For reaches where sedimentation occurs regularly as a result of gradual slumping, quiescent deposition, or regular erosion due to waves and wakes, the problem reduces to a deterministic least-cost replacement problem. Where sedimentation rates are uncertain, the risk of sediment encroachment into the navigation channel becomes a concern. Where sedimentation rates are probabilistic and independently distributed in time, encroachment probabilities and expected dredging costs can be calculated for a variety of dredging schedules. This risk and cost analysis allows explicit specification of risk-cost trade-offs in dredge scheduling. These methods are applied to an example case where existing dredging costs are compared with those estimated using these new dredge scheduling techniques. Extensions of these methods could be applied to multiple-reach dredge scheduling, sizing sediment traps, and scheduling dredging with explicit consideration of environmental impacts. (Author's abstract)
W90-07734

SEDIMENTATION IN THE RIMOV RESERVOIR.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
R. Porcalova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 349-353, 1989. 5 fig, 1 tab, 6 ref.

Descriptors: *Czechoslovakia, *Reservoir sediments, *Reservoirs, *Sedimentation rates, Algae, Chlorophyll a, Dry weight, Epilimnion, Fluctuations, Phosphorus, Sediments, Seston.

Sedimentation rates were measured in the Rimov Reservoir, Czechoslovakia during 1986. Sedimenting material was collected using sediment traps in various depths of water column. Plexiglass sediment traps (length to diameter ratio of 5) were exposed in the epilimnion (3 m and 8 m) and 5 meters above the bottom (37 m). Exposure time to traps was one week from April to July, two weeks from July to December. The collected material was analyzed for dry weight, total phosphorus and chlorophyll a. Phosphorus down-fluxes from the epilimnion correlated with total trapped matter and with chlorophyll a in the sediments. Phosphorus sedimentation rates from April to September ranged from 0.6 to 8.0 mg/square m/day at 3 m depth, from 2.2 to 13.0 mg/square m/day at 8 m, and from 2.2 to 36.0 mg/square m/day at 37 m. The average phosphorus sedimentation rate from the epilimnion was estimated at 7 mg/square m/day for the period from May to September. The sedimentary flux of seston was affected by algal density and its species composition. The main part of allochthonous material flowing into the Rimov Reservoir is deposited in a small upper part of the reservoir. (Author's abstract)
W90-07743

TESTS OF SELECTED SEDIMENT-TRANSPORT FORMULAS.
Iowa Inst. of Hydraulic Research, Iowa City.
T. Nakato.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 362-379, March 1990. 15 fig, 5 tab, 28 ref, 2 append.

Descriptors: *Data interpretation, *Mathematical equations, *Sacramento River, *Sediment transport, Flow characteristics, Particle size, Sediment discharge, Sediment distribution, Suspended sediments.

Eleven existing, sediment-transport formulas were tested against the field data measured at two United States Geological Survey gaging stations along the Sacramento River in California, whose bed material sizes are classified as those ranging from fine sand to coarse gravel. They include the Ackers-White Einstein-Brown, Engelund-Fredsoe, Engelund-Hansen, Inglis-Lacey, Karim, Meyer-Peter and Mueller, Rijin, Schoklitsch, Toffaleti, and Yang formulas. General flow and sediment input variables required by each transport function, as well as dependent variables, are summarized and detailed, and measured hydraulic and sediment quantities including bed-material size distributions are presented. The computed sediment discharge are tabulated for comparison, and are directly compared against the measured suspended sediment discharges. The computed values, however, are found to deviate significantly from the measured values except for a very few cases. The test results clearly demonstrate how difficult it is to predict sediment discharges in natural rivers. (Author's abstract)
W90-07830

ARMOR OR PAVEMENT.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
S. C. Jain.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 436-440, March 1990. 3 fig, 7 ref.

Descriptors: *Erosion, *Sediment distribution, *Sedimentation, Shear, Stream erosion.

The development and existence of a coarse surface layer sheltering finer sediment underneath, both in laboratory flumes and natural streams, have been investigated. The identification of the two flow regions gives rise to an improved understanding of the mechanics of, and the distinction between, armor and pavement formation. With increasing shear velocity, the surface layer coarsens in the armor region and becomes less coarse in the pavement. A coarse surface layer can be developed either by restricting the sediment influx through the upstream section of the channel reach or by allowing the shear velocity to vary during the evolution of the surface layer. With increasing time, the surface continues to coarsen, until the surface layer reaches an equilibrium in which either the eroded material discharge equals zero, or the eroded material is identical to the parent-bed material. The mobility of all size-sediments in the surface layer decreases and the availability of the coarser particles increases. The rate of decrease in the mobility of the finer grains is higher than that of the coarser grains. The composition and the discharge of the eroded material is controlled by the mobility and the availability of different size grains in the surface layer. (Brunone-PTT)
W90-07835

CHANNEL EVOLUTION OF THE HATCHIE RIVER NEAR THE U.S. HIGHWAY 51 CROSSING IN LAUDERDALE AND TIPTON COUNTIES, WEST TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
B. A. Bryan.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-598, 1990. 59p, 22 fig, 9 tab, 7 ref.

Descriptors: *Alteration of flow, *Bank erosion, *Bridge failure, *Channel erosion, *Channel morphology, *Channel scour, *Scour, *Tennessee, Alluvial channels, Sediment transport.

An investigation was conducted to describe the channel cross-section evolution near the bridge crossing of the Hatchie River at U.S. Highway 51 in Lauderdale and Tipton Counties, in West Tennessee. The study also included velocity and discharge distributions near the bridge crossing, and definition of streamflow duration and flood frequencies at the bridge site and comparison of these statistics with flows prior to the bridge collapse. Cross-section measurements at the site indicated that the channel was widening at a rate of 0.8 ft/year from 1931 through about 1975. The channel bed was stable at an elevation of about 235 ft. Construction of a south bound bridge in 1974 and 1975 reduced the effective flow width from about 4,000 to about 1,000 ft. Data collected from 1975 to 1981 indicated that the channel bed degraded to an elevation of about 230 ft and the widening rate increased to about 4.5 ft/year. The channel bed returned to approximately the pre-construction elevation of 235 ft as channel width increased. The widening rate decreased to about 1.8 ft/year from 1981 through 1989. Channel-geometry data indicated that recent channel morphology changes along the toe of the right bank have resulted in continued bank undercutting and bank failure. Cross-section geometry and flow-velocity distributions from measurements made from April 6 through 10, 1989, indicate that there is a high-flow meander pattern through this river reach and that the bridges are located at the point where the current strikes the right bank. (USGS)
W90-07840

HYDROLOGY OF THE CASTLE LAKE BLOCKAGE, MOUNT ST. HELENS, WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 8D.
W90-07859

VERTICAL AND LATERAL DISTRIBUTION OF FINE-GRAINED PARTICULATES IN PRAIRIE AND CORDILLERAN RIVERS: SAMPLING IMPLICATIONS FOR WATER QUALITY PROGRAMS.
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W90-07911

EVIDENCE FOR SEDIMENTING PARTICLES AS THE ORIGIN OF THE MICROBIAL COMMUNITY IN A COASTAL MARINE SEDIMENT.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
J. A. Novitsky.
Marine Ecology Progress Series MESEDT, Vol. 60, No. 1/2, p 161-167, February 1990. 3 tab, 24 ref.

Descriptors: *Coastal waters, *Marine sediments, *Microorganisms, *Particulate matter, *Sedimentation, Bacteria, Canada, Colonization, Cores, Decomposition, Ecosystems, Protozoa, Sediment sampler, Species composition, Water-sediment interfaces.

The origin of the microbial community in a coastal marine sediment was investigated by examining the physical, chemical and microbial characteristics of the sedimenting particles in Halifax Harbor, Canada. Particles were collected using particle interceptor traps placed on the sediment surface. The measured rate of particle accumulation compared to the sediment accumulation rate indicates that over 85% of the dry weight of the particles is removed (including resuspension) or solubilized before deposition as sediment. Active decomposition is facilitated by the large microbial community present. The particles are heavily colonized by both bacteria and protozoa before they reach the sediment such that the microbial communities of

the sinking particles and sediment-water interface are nearly indistinguishable. The particles and sediment are also similar with respect to community growth rates and carbon, nitrogen, and ATP content. Artificial sediment cores inserted into the sediment and left in place for one year were colonized only to a depth of 4 centimeters. The data indicate that an extensive microbial community is already established on particles before they become sediment and that in situ sediment colonization is not necessary for the establishment of the sediment microbial community. (Author's abstract)
W90-07943

METHOD FOR MODELING WATER TABLE AT DEBRIS AVALANCHE HEADSCARPS.
British Columbia Univ., Vancouver.
P. Buchanan, K. W. Savigny, and J. De Vries.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 61-88, February 1990. 13 fig, 4 tab, 34 ref. Natural Sciences and Engineering Research Council of Canada through Operating Grant No. A1923 and University of British Columbia Equipment Grant No. 0071.

Descriptors: *Debris avalanches, *Detritus, *Flooding, *Landslides, *Model studies, *Storms, *Water table profiles, Headscarps, Mass wasting, Soil erosion, Washington, Water table fluctuations.

Heavy rainfall during a January 9 and 10, 1983 storm triggered numerous debris avalanches and associated debris torrents in the Smith Creek basin, western Whatcom County, Washington. Rainfall hyetographs and soil parameters are entered in a one-dimensional, vertical, transient, unsaturated finite-difference model to produce vertical soil discharge rates at selected debris avalanche headscarps. The discharge rates are entered in a kinematic wave equation to model water table profiles above the headscarps. Factors controlling hydrologic response to rainfall are assessed. The discharge rates and water tables modeled for the failure-initiating, January 1 storm are distinguished from those modeled for other severe storms which did not trigger widespread debris avalanches. In most cases the January 1983 water tables were clearly higher than water tables developed during the December 1979 storm. Two of the headscarps became saturated to the surface during both storms, hence, the water tables reached similar levels. For planar slopes the maximum vertical discharge over one to three hours was critical to stability. Drainage depressions were generally farther from drainage divides, and the discharge over longer periods was more critical to stability. With the January 1983 storm as a calibration, the model has the potential for use in predicting the risk of avalanche recurrence. A suite of rainfall intensity-duration combinations that produce similar peak soil discharge rates could be derived. Discharges rates could then be used to predict water table profiles and the circumstances under which failure would occur for different types of debris avalanches. (Author's abstract)
W90-07978

SALINITIES AND SEDIMENT TRANSPORT IN THE BOLIVIAN HIGHLANDS.
Office de la Recherche Scientifique et Technique Outre-Mer, La Paz (Bolivia).
J. L. Guyot, M. A. Noriega, H. Calle, and J. Quintanilla.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 147-162, February 1990. 10 fig, 3 tab, 8 ref.

Descriptors: *Bolivia, *River basins, *Runoff, *Salinity, *Sediment transport, Erosion, Evaporation, Flood plains, Lakes, Mineralization.

Salinities and sediment loads of the rivers of the entire interior drainage basin of the Lake Titicaca, Rio Desaguadero, Lake Poopo and salars, as well as their evolution from upstream to downstream, were characterized on the basis of the results of four samplings during runoff periods. The regimes of dissolved and suspended matter transport are characterized with periodic measurements and samplings at hydrometrical stations over several years. Mechanical and chemical erosion rates were calculated for the basins that drain the Western

(Rio Mauri) and Eastern (Rio Suches) Cordilleras of the Bolivian Andes. Waters coming from the Eastern Cordillera are weakly mineralized, generally of calcium-bicarbonate type, and show quite low suspended sediment contents. The rivers from the highlands and from the Western Cordillera are generally quite mineralized and of sodium-chloride type. Upstream to downstream evolution shows an increase of mineralization through flood plains or lakes, due to evaporation; however, suspended sediment coming mostly from the Western Cordillera, is deposited in this fluvio-lacustrine system. A transported matter budget has been calculated from results of regular samplings at several stations. The mechanical erosion rates range from 21 t/sq km/yr for the Rio Suches basin, which drains a small massif of the Eastern Cordillera, to 640 t/sq km/yr for the Rio Mauri basin, which is underlain by volcano-sedimentary rocks of the Western Cordillera. The budget of dissolved matter shows that about 70% comes from Lake Titicaca. The chemical erosion rates for the basins of the Rio Suches and Rio Mauri are respectively 9 and 87 t/sq km/yr, i.e. 2 and 7 times less than the mechanical erosion. (Author's abstract)
W90-07983

RADIOMETRIC DATING OF THE UNITED KINGDOM SWAP SITES.
Liverpool Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
For primary bibliographic entry see Field 5C.
W90-08097

LEAD-210 CHRONOLOGY OF THE SCANDINAVIAN SWAP SITES.
Uppsala Univ. (Sweden). Dept. of Physics.
For primary bibliographic entry see Field 5C.
W90-08098

MODEL-B SEDIMENT-CONCENTRATION GAGE: FACTORS INFLUENCING ITS READINGS AND A FORMULA FOR CORRECTING ITS ERRORS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 7B.
W90-08166

INVESTIGATION OF TURBULENT FLOW OVER DUNES.
Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
For primary bibliographic entry see Field 2E.
W90-08251

LINEAR HYPERBOLIC MODEL FOR ALLUVIAL CHANNELS.
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
H. Zhang, and R. Kahawita.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 478-493, April 1990. 6 fig, 15 ref, 3 append. National Science and Engineering Research Council of Canada Grant OGP0008846.

Descriptors: *Alluvial channels, *Channel morphology, *Flow models, *Model studies, *Sediment transport, Aggradation, Boundary conditions, Mathematical models, River beds, Stream gradient, Transport rates.

Various activities, like changes in river grade, cross-sectional shape, liquid discharge, or sediment yield associated with upstream hydraulic structure or land-use changes, may disturb the delicate equilibrium between hydraulic and sediment-transport parameters, leading ultimately to aggradation or degradation along a river reach. The exact linear solutions for the sediment transport and bed form evolution for one-dimensional sediment-water two-phase motion have been obtained using the St. Venant shallow-water equations with the assumption of quasi-steady flow. These solutions are applicable to alluvial channels of infinite length, initially at equilibrium followed by an arbitrary forcing

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function of either sediment transport or bed elevation imposed as an upstream boundary condition. The solutions have been used to predict aggradation in a channel due to constant overloading. Comparison of the results with available experimental data and with the solution obtained from a parabolic model is satisfactory. The present theory is significant conceptually since it provides valuable insight into the physical phenomenon as well as into the mathematical behavior of the solutions. (Author's abstract)
W90-08252

MECHANICS OF LOCAL SCOUR AROUND SUBMARINE PIPELINES.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
For primary bibliographic entry see Field 8B.
W90-08254

FRICTION FACTOR OF ARMORED RIVER BEDS.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
J. Gessler.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 531-543, April 1990. 2 fig, 3 tab, 7 ref, append.

Descriptors: *Alluvial channels, *Channel morphology, *Flow friction, *Hydraulic roughness, *River beds, *Sediment transport, *Sedimentation, Factor analysis, Flow depth, Friction, Irrigation canals, Mathematical analysis, Particle size, Sediment discharge.

Computations of normal depth of flow for a given discharge or of discharge for a given normal depth of flow in alluvial channels require knowledge of the friction factor. Friction factors of armored river beds at the discharge that forms the armor coat were investigated. The analysis showed that the friction factor is rather independent of grain-size distribution of the material forming the bed and the maximum grain size of this material. The major controlling parameter is the slope of the energy grade line. These unexpected results are explained by the coupling of the friction factor with the incipient motion problem and the rearrangement of the grains of the coarsest fraction in the armor coat. Field data collected in irrigation canals support the results obtained from laboratory experiments. (Author's abstract)
W90-08255

BED EVOLUTION IN CHANNEL BEDS.
National Taiwan Univ., Taipei. Dept. of Civil Engineering.
C. L. Yen, and S. Y. Ho.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 544-562, April 1990. 8 fig, 1 tab, 32 ref, append.

Descriptors: *Channel morphology, *Channel stability, *Mathematical models, *Model studies, *River beds, *Sediment transport, Flow characteristics, Regression analysis, Rivers.

Flow characteristics and sediment movement are much more complex in channel bends than in straight channels. A numerical model for simulation of temporal bed evolution in channel bends with fixed walls was constructed and verified with laboratory experiments. The model is based on governing equations of flow and sediment motion, with some simplifying assumptions. Numerical experiments were conducted, using the model to investigate influences of various factors on bed evolution. It was found that the process of bed evolution in channel bends with steady discharge and uniform sediment can be approximated by a complementary exponential decay function of a time parameter. A regression equation was established for the coefficient as a function of flow condition, bend geometry, and sediment size. These relations, the numerical model, or both, may be applied to evaluate evolution of bed topography in river bends. Numerical results from this study were verified with laboratory experiments. (Author's abstract)

W90-08256

REDISTRIBUTION OF SEDIMENTS IN THREE SWEDISH LAKES.
Uppsala Univ. (Sweden). Dept. of Hydrology.
L. Bengtsson, T. Hellstrom, and L. Rakoczi.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 167-181, March 15, 1990. 4 fig, 7 tab, 19 ref.

Descriptors: *Lake sediments, *Limnology, *Sediment distribution, *Sediment transport, Bottom currents, Erosion, Lake Erken, Lake Tamnaren, Lake Valloxen, Sedimentation, Shear stress, Storms, Suspended solids, Sweden.

Sedimentation and redistribution of fine sediments in three Swedish lakes of different character, Lake Tamnaren, Lake Erken, and Lake Valloxen, have been investigated using settling sediment traps. The bottom shear stress from wind generated waves are calculated and the extension of erodible bottom area is related to wind conditions. Wave induced erosion and deposition during and after cessation of storms in different parts of a lake are discussed theoretically. It is shown that a single one year storm may redistribute more bottom material than the accumulated resuspension caused by frequent but small wind events. The settling sediment trap deposition and the concentration of suspended solids are related to the extension of erodible bottom area of particular storms. It is found that in lakes where there are relatively large areas of erosion bottoms, resuspended material from the part of the lake most susceptible to strong winds of large fetch constitutes a major part of the settled material on deep bottoms. The annual net sedimentation in Lakes Erken and Valloxen is 2-3 kg/sq m. (Author's abstract)
W90-08310

PROCESSES OF MARINE DISPERSAL AND DEPOSITION OF SUSPENDED SILTS OFF THE MODERN MOUTH OF THE HUANGHE (YELLOW RIVER).
Virginia Inst. of Marine Science, Gloucester Point.
L. D. Wright, W. J. Wiseman, Z. S. Yang, B. D. Bornhold, and G. H. Keller.
Continental Shelf Research CSHRDZ, Vol. 10, No. 1, p 1-40, January 1990. 23 fig, 2 tab, 56 ref.

Descriptors: *Deltas, *Deposition, *Mathematical models, *Model studies, *River mouth, *Sediment transport, *Silt, *Yellow River, China, Discharge measurement, Flood discharge, Numerical analysis, Tidal currents, Turbidity, Underflow.

The processes responsible for the transport and deposition of concentrated suspended silts over the delta front of the Huanghe River, China, were observed during three cruises and have been modeled numerically. Cruises were conducted during normal discharge conditions in spring 1985 and summer 1986, and during low-discharge storm-dominated conditions in autumn 1987. During the first two cruises, the shallow delta-front top was covered by a turbid water mass. Strong parabathic tidal currents resuspended newly deposited muds and advected them alongshore. Near a break in slope, the turbid layers plunged beneath the ambient water and descended the delta-front slope as gravity-driven hyperpycnal underflows. In 1987 these underflows occurred only during an intense storm that resuspended delta-front sediments to produce underflows. It is inferred that gravity-driven underflows constitute the most important mode of suspended sediment transport across isobaths. Concentrated and channelized 'point source' underflows, apparently associated with flood conditions, were not observed but were inferred from morphological evidence and were modeled numerically, showing that the Coreolis force and ambient momentum should cause appreciable curvature to the paths of underflows, while entrainment of ambient mass contributes to underflow decay. Early extinction of all underflow types is suggested by field and modeling results, and is considered to be responsible for extremely rapid delta-front deposition and for the fact that most of the sediments discharged by the Huanghe remain close to the mouth. (Author's abstract)
W90-08323

MEASUREMENTS OF TURBULENCE IN THE BENTHIC BOUNDARY LAYER OVER A GRAVEL BED.
Proudman Oceanographic Lab., Birkenhead (England).
J. J. Williams, P. D. Thorne, and A. D. Heathershaw.
Sedimentology SEDIAT, Vol. 36, No. 6, p 959-971, December 1989. 7 fig, 3 tab, 47 ref.

Descriptors: *Analytical methods, *Bed load, *Benthic environment, *Boundary layers, *Geophysical methods, *Sediment transport, *Statistical analysis, *Turbulent flow, Data interpretation, Gravel, Tides.

It is generally recognized that the mathematical description of sediment dynamics will be improved through an understanding of geophysical turbulence. The turbulence characteristics of the benthic boundary layer over coarse sediments were examined as a step towards the realization of such a description. Examination of the turbulence was conducted using spectral, correlation, quadrant and statistical analyses, and a number of features were identified. Mean eddy length scales obtained using spectral and autocorrelation techniques were similar. The interpretation of the duration and interval between the intermittent 'bursting' events, scaled using outer flow variables, was dependent upon the sampling interval. Autocorrelation analysis revealed a high correlation between bedload transport and the instantaneous horizontal flow component rather than instantaneous kinematic stress. From the standpoint of developing prognostic transport models based in physically realistic benthic flow processes, it is considered that turbulence measurements will lead to such formulation. (Author's abstract)
W90-08376

COMPARISONS BETWEEN ACOUSTIC MEASUREMENTS AND PREDICTIONS OF THE BEDLOAD TRANSPORT OF MARINE GRAVELS.
Proudman Oceanographic Lab., Birkenhead (England).
J. J. Williams, P. D. Thorne, and A. D. Heathershaw.
Sedimentology SEDIAT, Vol. 36, No. 6, p 973-979, December 1989. 1 fig, 2 tab, 21 ref.

Descriptors: *Acoustics, *Bed load, *Bed-load discharge, *Sediment transport, *Turbulent flow, Comparison studies, England, Estimating equations, Gravel, Tidal effects, West Solent.

Continuous, detailed records of marine transport were obtained acoustically in the West Solent, England over nominally flat chert gravel bed and compared with bedload transport rates predicted by five bedload transport equations using measurements of the near-bed turbulent current flow. When mean flow data are used in these equations, total bedload transport rates estimates are similar to those measured. However, when instantaneous flow data are used, total bedload transport rates are over estimated by approximately one order-of-magnitude. Increasing the threshold value by 25% to account for overestimations resulting from the use of instantaneous flow data gave total bedload transport rates estimates that agreed moderately well with the measured rates. When modified in this way, however, the published equations failed to simulate accurately the observed intermittent characteristics of marine gravel transport. A new bedload transport expression based on the acoustic measurements was found to simulate well temporal variations in bedload transport rates, and provide estimates of total bedload that agreed closely with the acoustic measurements. Based on the acoustic measurements, an empirical equation was obtained that gives accurate estimates of total bedload transport rates over a tidal cycle and simulates well the intermittent characteristics of marine bedload transport. (Chonka-PTT)
W90-08377

HUMMOCKY CROSS-STRATIFICATION AND POST-VORTEX RIPPLES: LENGTH SCALES AND HYDRAULIC ANALYSIS.
University of Southern California, Los Angeles. Dept. of Geography.
D. J. Sherman, and B. Greenwood.
Sedimentology SEDIAT, Vol. 36, No. 6, p 981-986, December 1989. 1 tab, 29 ref. NSF Grant SES-8521344.

Descriptors: *Hydrodynamics, *Lacustrine environment, *Sediment transport, *Sedimentation, *Sedimentology, *Wave-current interactions, Hummocky cross-stratification.

The theory that a structure reported by hummocky cross-stratification from a shallow lacustrine environment is, instead, bedding formed by simple post-vortex oscillation ripples was examined. Using measured flow data, existing models of bedform generation based upon wave orbital velocity, orbital diameter and grain diameter were shown not to support a simple post-vortex ripple interpretation. In particular, the relative steepness of the structure refutes such an origin. The structural characteristics of the lacustrine cores most closely match those associated with classic hummocky cross-stratification and were produced under a combined oscillatory/quasi-steady flow field. With regard to preservation potential, there is always a potential for preservation of structural deposits once formed. Evidence of hummocky cross-stratification in box cores from a modern environment implies that the bedding has already been preserved for a finite time interval. The hydrodynamical and sedimentological conditions described are not exclusive to lacustrine environments. A large number of coastal regions exist which are microtidal and storm-dominated. Therefore, there is no obvious reason not to extend the preservation potential of small-scale hummocky cross-stratification to certain marine environments. (Chonka-PTT)
W90-08378

COAGULATION AND TRANSPORT OF SEDIMENTS IN THE GIRONDE ESTUARY.
Delaware Univ., Newark. Center for Colloidal Science.
For primary bibliographic entry see Field 2L.
W90-08379

SUBMARINE SEDIMENTATION ON A DEVELOPING HOLOCENE FAN DELTA.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Atlantic Geoscience Centre.
D. B. Prior, and B. D. Bornhold.
Sedimentology SEDIAT, Vol. 36, No. 6, p 1053-1076, December 1989. 23 fig, 1 tab, 32 ref. NSF Grant DPP-850118.

Descriptors: *Canada, *Fjords, *Fluvial sediments, *Sediment distribution, *Sediment transport, *Sedimentation, Bottom sampling, Deltas, Turbidity currents, Turbidity flow.

The submarine morphology, sediments, and three-dimensional geometry of a developing fan delta were studied using data from acoustic surveys, bottom sampling, and observations from a manned submersible. The fan system is being built in a British Columbian fjord (water depth 410 m) supplied with coarse-grained sediments from a fjord-size river. Construction of the subaqueous fan began about 10-12,000 yr BP and is ongoing. The system is analogous to part of one fault-uplift sedimentation cycle in ancient fan deltas. Initially, when offshore relief was at a maximum, acoustically chaotic sediment wedges were emplaced over fjord-bottom glaciomarine deposits. Subsequent aggradation/progradation resulted in moderately dipping sequences interrupted by local chaotic units. The present fan surface (average slope 13 degrees) is divided into six zones arranged concentrically from the fan apex, on the basis of form, sediment and process interpretations. Continued subaqueous fan growth results from settling of river-derived sediments from suspension and downslope sediment dispersal by episodic gravity flows, apparently fed by underflows from the river. (Author's abstract)

W90-08380

ACCURACY OF THE EIKONAL TYPE APPROXIMATIONS FOR SIZING PARTICLES IN COHESIVE SEDIMENTS.
University Coll., Cardiff (Wales). Dept. of Physics.
For primary bibliographic entry see Field 7B.
W90-08386

SEMIARID SOIL AND WATER CONSERVATION.
For primary bibliographic entry see Field 3F.
W90-08532

SOIL EROSION PROCESS.
Finkel and Finkel, Yoqneam (Israel).
H. J. Finkel.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 27-37, 3 fig, 3 tab, 12 ref.

Descriptors: *Erosion, *Semiarid lands, *Soil erosion, *Vegetation effects, Gullies, Rain, Rills, Sheet erosion, Stream erosion, Vegetation.

Soil erosion may be defined as the detachment and removal of soil material from the surface of the ground, either by water or by wind. Water erosion may take several forms such as drop splash, surface flow erosion (sometimes called sheet erosion), rill, gully, stream bank, and channel erosion. When a drop of water falls upon the soil it breaks up into a ring of droplets which rebound from the surface in a crown-shaped structure. At the moment of initial impact the kinetic energy of the falling drop detaches some of the soil particles at the surface; these rise with the droplets and are re-deposited when the droplets fall. The net result of all drop splash is a continuous movement of soil down the slope. The amount of the displacement on the downhill side, under typical conditions, may be 10 to 15% greater than on the uphill side. With continuous rainfall over a period of hours, this represents a substantial movement of soil down the slope. The actual rate of soil erosion from drop splash depends upon characteristics of the rain, and characteristics of the soil. Vegetative cover reduces splash erosion in two ways; it decreases the erosive power of the rain, and it increases the resistance of the soil surface. If the area is covered with a dense growth of low trees, bushes, and shrubs which intercept the falling drops, the new fall height will be considerably lower and the drops will not reach terminal velocity upon impact. Since the kinetic energy of impact is a function of the square of the velocity, the plant cover will greatly reduce the erosive power of the rain. The resistance of the soil to erosion is also greatly enhanced by both the crowns and the roots of the vegetation. There are three principal ways in which soil is detached and transported by a current of water: (1) rolling; (2) lifting; and (3) abrasion. Several types of erosion are caused by surface flow. They are: (1) sheet erosion; (2) rill erosion; (3) gully erosion; and (4) streambank erosion. (See also W90-08532) (Lantz-PTT)
W90-08534

AGRONOMIC MEASURE FOR SOIL AND WATER CONSERVATION.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 3F.
W90-08535

GULLY CONTROL.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 4D.
W90-08540

WIND EROSION.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 4D.
W90-08541

CAVES AND DRAINAGE NORTH OF THE GREEN RIVER.
For primary bibliographic entry see Field 2F.
W90-08550

GEOMORPHIC HISTORY OF THE MAMMOTH CAVE SYSTEM.
State Univ. of New York Coll. at Oneonta. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2F.
W90-08554

SEDIMENTATION IN THE RESERVOIR OF THE ALTENWOERTH HYDROPOWER PLANT.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtschaft.
H. P. Nachtnebel, W. Summer, H. Mueller, and B. Schwaighofer.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 173-180, 1990. 5 fig, 2 tab, 26 ref.

Descriptors: *Altenwoerth Hydropower Plant, *Environmental effects, *Reservoirs, *Sedimentation, *Water resources development, Bottom sediments, Electric powerplants, Heavy metals, Mathematical models, Model studies, Particle size, Sediment transport.

The sedimentation process in the reservoir of the hydropower scheme at Altenwoerth, located on the Austrian part of the Danube River about 60 km upstream from Vienna, is discussed. Starting in 1976 the aggradation of the river bed has been monitored annually to estimate the sedimentation rate along a longitudinal section in the reservoir. Further, cores were taken over the whole sediment layer to analyze the grain size distribution, the bulk density, the mineralogic structure of the sediment, and the heavy metal concentrations in the layer. It was found that the annual average sedimentation of suspended material amounts to 390,000 cu m/annum. The grain size of the samples varies from well sorted sands to poorly sorted, clay rich sediments. The heavy metal concentrations refer to the fraction < 20 micrometers. When compared to the guidelines for sewage sludge disposal, the observed heavy metal content of zinc and lead is slightly above their respective limits. A one dimensional sedimentation model which describes the accumulation during the operation period from 1976 to 1985 was applied to Altenwoerth situation. The model is related to the unit stream power concept and is based on the transport capacity equation of Engelund and Hansen. Model results were satisfactory for both the quantity of the sediment and its gradation. (Author's abstract)
W90-08628

RADIOACTIVITY OF SEDIMENTS IN DANUBE RESERVOIRS IN AUSTRIA BEFORE AND AFTER THE CHERNOBYL ACCIDENT.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
For primary bibliographic entry see Field 5B.
W90-08633

2K. Chemical Processes

ON-LINE PRECONCENTRATION OF SILVER ON ACTIVATED ALUMINA AND DETERMINATION ON BOREHOLE WATER BY FLOW INJECTION ATOMIC ABSORPTION SPECTROPHOTOMETRY.
For primary bibliographic entry see Field 7B.
W90-07568

CHLORINE-36 TRACING OF SALINITY SOURCES IN THE DRY VALLEYS OF VICTORIA LAND, ANTARCTICA.
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
C. A. Carlson, F. M. Phillips, D. Elmore, and H. W. Bentley.
Geochimica et Cosmochimica Acta GCACAK, Vol. 54, No. 2, p 311-318, February 1990. 4 fig, 4 tab, 55 ref, append. NSF Grant DPP-8314621, U.S. Department of Energy Contract DE-ACD9-76SR00-819.

Group 2K—Chemical Processes

Descriptors: *Antarctica, *Chlorides, *Chlorine radioisotopes, *Geochemistry, *Groundwater chemistry, *Saline lakes, *Salinity, Chlorine-36 tracing, Dry Valleys, Model studies, Victoria Land, Water sampling.

Chlorine-36 (36Cl) was used to trace the origins of salts in six saline lakes in the Dry Valleys of Southern Victoria Land, Antarctica. Characteristic 36Cl signatures were estimated for the various potential chloride sources, which include atmospheric deposition, rock weathering, seawater, and deep ground water. 36Cl/Cl ratios were measured in natural waters and salts from the Dry Valleys. Dilute lake waters (Cl(-) less than 100 mg/L) were found to have 36Cl/Cl ratios in the range 1 to 17 x 10 to the minus 13th power, whereas saline waters (Cl(-) greater than 1000 mg/L) had ratios in the range 9 to 40 x 10 to the minus 15th power. Simple mixing models were employed to quantify the relative contributions of the various chloride sources to Lake Vanda and Don Juan Pond. These results show that Lake Vanda has received its chloride from both deep ground water and the Onyx River. Don Juan Pond has received nearly all its chloride from deep ground water, probably ultimately from rock-water interaction. Deep ground water is the principle source of chloride to the lakes of Wright Valley. However, preliminary data suggest that marine-derived salts or relict sea water may be a significant source of chloride to the lakes of Taylor Valley, implying a possible recent invasion that did not affect Wright Valley. (Author's abstract)
W90-07569

COMPARISON OF OXIDATION-REDUCTION POTENTIALS CALCULATED FROM THE AS(V)/AS(III) AND FE(III)/FE(II) COUPLES WITH MEASURED PLATINUM-ELECTRODE POTENTIALS IN GROUNDWATER.
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
T. R. Holm, and C. D. Curtiss.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 1, p 67-81, December 1989. 3 fig, 2 tab, 45 ref.

Descriptors: *Arsenic, *Groundwater chemistry, *Iron oxides, *Oxidation-reduction potential, *Water chemistry, Chemical reactions, Chemical reduction, Groundwater quality, Illinois, Monitoring, Oxidation.

Oxidation-reduction (redox) conditions affect groundwater quality in many ways. For many priority pollutant metals different oxidation states may have different solubilities and adsorption characteristics. Redox conditions indirectly affect the transformation and degradation of many organic substances by restricting the microbial population available to mediate any transformations. For many reasons, it is desirable to have an indicator of redox conditions in an aquifer system. Redox potentials calculated from arsenic speciation in 63 groundwater samples collected from shallow groundwaters in east-central Illinois showed fair correlation with measured platiaum-electrode potentials (Eh). The observed bias in calculated potentials relative to measured Eh values could not be explained by analytical imprecision. Redox potentials calculated from Fe concentrations showed better correlation with measured potentials than the As potentials. Arsenic speciation may be a useful supplement to Eh measurements and concentrations of other solutes, but is probably not a good indicator of redox conditions when alone. (Tappert-PTT)
W90-07618

ELECTRODE MEASUREMENT OF REDOX POTENTIAL IN ANAEROBIC FERRIC/FERROUS CHLORIDE SYSTEMS.
Colorado School of Mines, Golden. Dept. of Chemistry and Geochemistry.
T. J. Grundl, and D. L. Macalady.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 1, p 97-117, December 1989. 6 fig, 3 tab, 53 fig. EPA Cooperative Agreement No. CR-813077-01.

Descriptors: *Data acquisition, *Electrodes, *Iron compounds, *Oxidation-reduction potential, *Water analysis, *Water chemistry, Chemical properties, Nernst equation, On-site tests.

The interpretation of redox potentials obtained from electrode measurements in natural waters is subject to numerous complications. These complications include mixed potentials, internal redox disequilibria within the aqueous system, and electrochemical disequilibria between electrode and the aqueous system. The ferric-ferrous iron pair is a common naturally occurring that exhibits reversible behavior, and natural redox systems that are dominated by iron are considered to be at redox equilibria. The behavior of two inert redox electrodes (Pt and wax-impregnated graphite) was investigated in anaerobic ferrous and ferric chloride solutions, in order to establish if these electrodes respond to the Fe(+++)/Fe(++) couple in a Nernstian manner. A new method for determining dissolved ferric iron at any point in time was used which permitted the calculation of Eh values that are independent of variations in the solubility of ferric oxyhydroxides. This method is applicable to simple iron solutions at pH levels of 4 or less. In solutions of ionic strength greater than 0.005M, both electrodes yielded measured potentials that correspond to the value calculated by the Nernst equation. In solutions of ionic strength less than 0.005M, electrode response became non-Nernstian. Low exchange current densities did not appear to be responsible for the non-Nernstian behavior. (Tappert-PTT)
W90-07620

CONTROLLING MECHANISMS FOR STREAM WATER CHEMISTRY AT THE PRISTINE INGABEKKEN SITE IN MID-NORWAY: SOME IMPLICATIONS FOR ACIDIFICATION MODELS.
Senter for Industriforskning, Oslo (Norway).
N. Christophersen, R. D. Vogt, C. Neal, H. A. Anderson, and R. C. Ferrier.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 59-67, January 1990. 6 fig, 12 tab, 36 ref.

Descriptors: *Acid rain, *Acidification, *Model studies, *Norway, *Water chemistry, Acid streams, Aluminum, Hydrogen ion concentration, Ion exchange, Snowmelt, Water quality.

Surface water acidification is the result of complex interactions between anthropogenic impacts and naturally occurring processes in catchments. Stream water at the 18.7 ha pristine Ingabekken catchment, on granitic bedrock, in mid-Norway has been studied for 2 years, including intensive episode studies in the spring and autumn. Routine sampling has been conducted since 1986 on a weekly/biweekly basis. The pH and conductivity were determined for all samples, and selected samples were analyzed for several metals, inorganics, total organic carbon, and total inorganic carbon. The pH varied from over 7 at base flow to 5 or slightly below at high flow, while inorganic monomeric Al was <1micro m for all flow conditions. The lowest pH (4.8) was observed in the early snowmelt during release of meltwater highly enriched in sea salts. The cation exchange capacity and base saturation of organic soils were comparable to those found at the acidified Birkenes site in southern Norway, but the ratio of exchangeable Al to exchangeable H(+) was much lower at Ingabekken. This suggests that soils could undergo a transition during acidification whereby exchangeable H(+) is replaced by aluminum. Such a transition may well be important in understanding long-term trends in acidification but is not a feature of most models. (Author's abstract)
W90-07639

CONTAMINANT ACCUMULATION DURING TRANSPORT THROUGH POROUS MEDIA.
Los Alamos National Lab., NM.
For primary bibliographic entry see Field 5B.
W90-07642

URANIUM, VANADIUM, AND MOLYBDENUM IN SALINE WATERS OF CALIFORNIA.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.

G. R. Bradford, D. Bakhtar, and D. Westcot.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 105-108, 1990. 5 tab, 18 ref.

Descriptors: *California, *Evaporation ponds, *Molybdenum, *Saline lakes, *Saline water, *Uranium, *Vanadium, *Water chemistry, Agricultural runoff, Correlation analysis, Heavy metals, Path of pollutants, Salinity, Soil solution.

Analyses of saline water samples from large salt water bodies, agricultural drainage and evaporation ponds, and soil water extracts were used to determine the extent of elevated uranium (U), vanadium (V), and molybdenum (Mo) in agricultural environments of the San Joaquin Valley. Saline water samples and soil extracts were pretreated by chelation and solvent extraction to separate and concentrate, U, V, and Mo for analyses. Mean concentrations of U, V, and Mo were considerably elevated in agricultural drainage and evaporation ponds of the San Joaquin Valley compared to saline waters of Salton Sea and Mono Lake. Relatively high correlation coefficients were observed between U, Mo, and salinity. (Author's abstract)
W90-07703

RATE-LIMITING STEPS IN THE DISSOLUTION OF FLUORITE.
Buenos Aires Univ. (Argentina). Plains Hydrology Inst.
For primary bibliographic entry see Field 5B.
W90-07728

DOLOMITE DISSOLUTION RATES AND POSSIBLE HOLOCENE DEDOLOMITIZATION OF WATER-BEARING UNITS IN THE EDWARDS AQUIFER, SOUTH-CENTRAL TEXAS.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2F.
W90-07730

DISSOLVED AMINO SUGARS IN THE RIMOV RESERVOIR (CZECHOSLOVAKIA).
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
For primary bibliographic entry see Field 2H.
W90-07736

PHOTO-INITIATED OXIDATIONS OF ORGANIC SUBSTANCES IN NATURAL WATERS BY MOLECULAR OXYGEN.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
S. Klementova, C. Budejovice, and D. M. Wagnerova.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 355-360, 1989. 4 fig, 1 tab, 19 ref.

Descriptors: *Catalysis, *Oxidation, *Oxygen, *Photochemistry, *Water chemistry, Catalysts, Catechol, Chemical reactions, Glycolaldehyde, Glycolic acid, Glyoxylic acid, Iron, Organic compounds, Phenols, Phenylalanine, Phthalic acid, Salicylic acid, Thermal reactions, Thioglycolic acid, Tryptophan.

Photo-initiated oxidations of several simple organic substances (aliphatic and aromatic) by molecular oxygen (in the presence of ferric iron as a catalyst) were studied. Compounds which were either present in natural waters or may serve as models of more complicated molecules were chosen: glycolic acid, glyoxylic acid, glycolaldehyde, thioglycolic acid, tryptophan, phenylalanine, phenol, catechol, salicylic acid and phthalic acid. The oxidation of all substrates was studied on irradiation (photochemical reaction) and in the dark (thermal reaction) in both cases with and without addition of a catalyst (ferric ions). It was obvious that only one substrate (thioglycolic acid) was oxidized without light--in the dark reaction--in the presence of the catalyst. Other substrates were oxidized only photochemically. In the cases of glycolic and glyoxylic acids, no reactions were observed even on irradiation if no catalyst was added to the reaction system. The effect of ferric ions in the photochemical oxidations of aliphatic substrates can be inter-

preted as a photocatalytic affect. This means that the photochemical reaction produces the active form of the catalyst which catalyzes a subsequent thermal reaction with oxygen. It has been shown that reactions of studied organic compounds with molecular oxygen are markedly influenced by irradiation. In these photo-initiated reactions, metal ions play a decisive role as photo-catalysts. In some cases even traces of metal are catalytically active. (Mertz-PTT)
W90-07744

URBAN NUTRIENT INPUTS AND PHYTO-PLANKTON BIOMASS IN A SMALL IM-POUNDMENT ON THE RIVER MURRAY, AUSTRALIA.
Murray-Darling Freshwater Research Centre, Albury (Australia).
For primary bibliographic entry see Field 5B.
W90-07747

METHOD FOR ESTIMATION OF PHYTO-PLANKTON DARK LOSSES BY APPLICA-TION OF 14C-TECHNIQUES.
Akademie der Wissenschaften der DDR, Berlin. Inst. fuer Geographie und Geooekologie.
For primary bibliographic entry see Field 7B.
W90-07753

TRANSPORT PREDICTION IN PARTIALLY STRATIFIED TIDAL WATER.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
For primary bibliographic entry see Field 2L.
W90-07831

MEASUREMENT OF REAERATION COEFFI-CIENTS FOR SELECTED FLORIDA STREAMS.
Geological Survey, Orlando, FL. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-07849

DEVELOPMENT OF PURGE AND TRAP WITH WHOLE COLUMN CRYOTRAPPING FOR THE ANALYSIS OF GROUNDWATER CONTAMINATED WITH ORGANIC CHEMI-CALS.
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5A.
W90-07857

ELIMINATION OF LONG LIVED FISSION PRODUCTS FROM RIVER SEDIMENT.
Novi Sad Univ. (Yugoslavia). Inst. of Physics.
For primary bibliographic entry see Field 5B.
W90-07915

RESPIROMETER FOR CONTINUOUS, IN SITU, MEASUREMENTS OF SEDIMENT OXYGEN DEMAND.
Hong Kong Polytechnic, Kowloon. Dept. of Applied Science.
For primary bibliographic entry see Field 7B.
W90-07925

ELECTRICAL CONDUCTIVITY AND TOTAL DISSOLVED SOLIDS: WHAT IS THEIR PRE-CISE RELATIONSHIP.
Hydrogeochemical Engineer and R.O. Consultant, 25, Eric Lock Road, Shrewsbury SY3 0HQ, England.
For primary bibliographic entry see Field 3A.
W90-07966

DISSOLVED GAS EVIDENCE FOR DENITRI-FICATION IN THE LINCOLNSHIRE LIME-STONE GROUNDWATERS, EASTERN ENG-LAND.
Department of Science (Geology Division), Anglia Higher Education College, Cambridge, CB1 1PT England.
For primary bibliographic entry see Field 5B.

W90-07977

SALINITIES AND SEDIMENT TRANSPORT IN THE BOLIVIAN HIGHLANDS.
Office de la Recherche Scientifique et Technique Outre-Mer, La Paz (Bolivia).
For primary bibliographic entry see Field 2J.
W90-07983

PHOSPHORUS EUTROPHICATION RE-SEARCH IN THE LAKE DISTRICT OF SOUTH WESTERN FRIESLAND, THE NETHER-LANDS: PRELIMINARY RESULTS OF ABIOT-IC STUDIES.
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
For primary bibliographic entry see Field 5C.
W90-08073

CHEMICAL EVOLUTION OF GROUND WATER IN THE MILK RIVER AQUIFER, CANADA.
National Water Well Association, Dublin, OH.
M. J. Hendry, and F. W. Schwartz.
Ground Water GRWAAP, Vol. 28, No. 2, p 253-261, March/April 1990. 6 fig, 4 tab, 23 ref.

Descriptors: *Aquifer characteristics, *Canada, *Geochemistry, *Geologic control, *Groundwater chemistry, *Ion transport, *Paleohydrology, *Water chemistry, Cation exchange, Diffusion, Erosion, Geochemical cycles, Glaciohydrology, Groundwater movement, Geochemical recharge, Ions, Shales, Surface-groundwater relations, Water analysis.

Well-defined trends are observed in the ion composition of groundwater from the Milk River (Canada) aquifer. Groundwater from the area of the subcrop has higher concentrations of $Na(+)$, $SO4(-2)$, $Ca(+2)$, and $Mg(+2)$ than immediately downgradient. Away from the area of the subcrop, $Na(+)$, $Cl(-)$, $HCO3(-) + CO3(-2)$, and $CH4$ concentrations increase systematically with increased residence time, pH decreases, and $Mg(+2)$ and $Ca(+2)$ concentrations are typically low (less than 0.1 mmol/L). Geologic changes play an important role in producing these chemical patterns. The first major geologic change was the erosion of the overlying confining beds in the recharge area about 500,000 years ago, enabling meteoric water with low concentrations of $Na(+)$ and $Cl(-)$ to enter the aquifer and displace preexisting water. The second major change was the deposition of glacial till in the area of the Milk River about 30,000 to 40,000 years ago. Water recharging through the till to the aquifer developed characteristically high concentrations of $Na(+)$, $SO4(-2)$, $Ca(+2)$, and $Mg(+2)$. Downgradient of the area of subcrop, the trends in $Na(+)$ and $Cl(-)$ are controlled by diffusion from the underlying confining shale. Analyses of groundwater and gas samples for sulfate reducers and groundwater and gas samples for sulfide and H2S, respectively, suggest that $SO4(-2)$ reduction is not a major process. Geochemical modeling suggests that $CO2$ gas is added to the groundwater with its increased residence time in the aquifer. The increase in $CO2$, $CH4$, and dissolved inorganic carbon can be attributed to methane fermentation. Geochemical modeling suggests that cation exchange plays a minor role in the chemical evolution of the groundwater. (Author's abstract)
W90-08195

REGIONAL ANALYSIS OF STREAM SALINI-SATION IN SOUTHWEST WESTERN AUSTRA-LIA.
Water Authority of Western Australia, Perth.
For primary bibliographic entry see Field 5B.
W90-08215

CHARACTERIZATION OF THE REDUCING PROPERTIES OF ANAEROBIC SEDIMENT SLURRIES USING REDOX INDICATORS.
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5B.
W90-08242

APPLICATION OF A MEMBRANE MODEL TO THE SORPTIVE INTERACTIONS OF HUMIC SUBSTANCES.
Geological Survey, Arvada, CO.
For primary bibliographic entry see Field 5B.
W90-08305

CHEMICAL REACTIONS OF ORGANIC COM-POUNDS ON CLAY SURFACES.
National Inst. for Environmental Studies, Ibaraki (Japan).
For primary bibliographic entry see Field 5B.
W90-08306

SEQUENTIAL FRACTIONATION OF SEDI-MENT PHOSPHATE.
Leiden Rijksuniversiteit (Netherlands). Dept. of Population Biology.
C. J. de Groot, and H. L. Golterman.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 143-148, March 15, 1990. 1 fig, 5 tab, 12 ref.

Descriptors: *Chelation, *Chemical analysis, *Fractionation, *Phosphates, Algae, Chemical interactions.

Through the use of sequential extractions with Ca-nitrolotriacetic acid and ethylene-diaminetetracetic acid, a separation was performed between iron bound phosphate and calcium bound phosphate in sediments; the remaining fraction, considered to be organic phosphate, was quantified as well. It was found that with the commonly used method of extraction with NaOH and H2SO4, less iron bound phosphate and much more calcium bound phosphate was found than with the chelating extractants. The organic phosphate pool in live and dead algal material and in some mud samples was partly hydrolyzed and therefore recoverable as inorganic phosphates with classical extractions. (Author's abstract)
W90-08308

HYDROCHEMICAL PROCESSES IN GROUNDWATER-DISCHARGE PLAYAS, CEN-TRAL AUSTRALIA.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
J. Jankowski, and G. Jacobson.
Hydrological Processes HYPRE3, Vol. 4, No. 1, p 59-70, January/March 1990. 6 fig, 2 tab, 30 ref.

Descriptors: *Australia, *Brines, *Geochemistry, *Groundwater chemistry, *Playas, *Saline lakes, Bicarbonates, Calcium, Chemical precipitation, Groundwater movement, Gypsum, Ion transport, Lake evaporation, Magnesium, Mineralization, Potassium, Salts, Saturation zone, Sodium, Sodium chloride, Sulfates.

A large groundwater system in the Amadeus Basin, central Australia, discharges to a chain of playa lakes 500 km long. The playas contain highly concentrated brines; these are sodium chloride-rich waters with appreciable magnesium and sulfate and very low concentrations of calcium and bicarbonate. Gypsum, glauberite, and other evaporite minerals are precipitating in the playas. The groundwaters evolve to brine by concurrent processes of dissolution, evaporative concentration, mineral precipitation, and mineralogical change. Chemical evolution is considered with reference to a concentration factor based on chloride. Ion transfer calculation demonstrate losses of magnesium and bicarbonate throughout, as a result of precipitation. Sodium, potassium, calcium, and sulfate are gained initially as a result of dissolution but lost subsequently as a result of precipitation. Larger playas in the chain, exemplified by Lake Amadeus, have dual shallow and deep groundwater flow paths whereas the smaller playas, exemplified by Spring Lake, have only shallow flow paths. Brines in the larger playas are diluted by deep groundwater and this is reflected in the degree of saturation attained with respect to particular minerals. Thus, saturation with respect to gypsum and glauberite is attained earlier in Spring Lake than in Lake Amadeus. Saturation with respect to halite is attained in Spring Lake but not in Lake Amadeus. Both

playas are undersaturated with respect to hexahydrite and sylvite although these minerals occur in efflorescent crusts in Spring Lake. (Author's abstract)
W90-08328

CHARACTERISTICS OF SUSPENDED SEDIMENT IN THE UPPER RHONE RIVER, SWITZERLAND, INCLUDING THE PARTICULATE FORMS OF PHOSPHORUS.
Geneva Univ. (Switzerland). Inst. F.-A. Forel.
For primary bibliographic entry see Field 5B.
W90-08330

EFFECTS OF BENTHIC FLORA ON ARSENIC TRANSPORT.
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-08351

CONTRAST IN WINTER RAINWATER COMPOSITION: MARITIME VERSUS CONTINENTAL RAIN IN EASTERN NORTH CAROLINA.
North Carolina Univ. at Wilmington.
For primary bibliographic entry see Field 5B.
W90-08368

ISOTOPIC COMPOSITION OF PRECIPITATION FROM TWO EXTRATROPICAL CYCLONES.
City Coll., New York. Dept. of Earth and Planetary Sciences.
For primary bibliographic entry see Field 2B.
W90-08369

GEOCHEMISTRY OF THE SANDSTONE AQUIFER, SOUTHERN WISCONSIN.
Syracuse Univ., NY. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-08403

APPLICATION OF GEOPHYSICS IN THE DELINEATION OF THE FRESHWATER/SALINE-WATER INTERFACE IN THE MICHIGAN BASIN.
Geological Survey, Lansing, MI.
For primary bibliographic entry see Field 2F.
W90-08405

CHEMICAL HYDROLOGY.
Nevada Univ. System, Las Vegas. Water Resources Center.
H. W. Hess, and W. B. White.
IN: Karst Hydrology: Concepts from the Mammoth Cave Area. Van Nostrand Reinhold, New York. 1989. p 145-174, 13 fig, 3 tab, 35 ref.

Descriptors: *Geochemistry, *Groundwater chemistry, *Karst hydrology, *Kentucky, *Mammoth Cave, *Water chemistry, Caves, Groundwater movement, Karst.

Karst aquifers, more than all others, are dynamic systems. There is a continuous chemical interaction between the moving groundwater and the carbonate wall rock. As a result of this, the internal porosity distribution and flow regimes of carbonate aquifers are continuously changing on a time scale of tens of thousands to millions of years. This phenomenon can be contrasted with silicate rock aquifers where there is indeed an influence of the aquifer wall rock on the chemistry of the moving groundwater, but there is relatively little change or at best an extremely slow change in permeability of the aquifer itself. Carbonate aquifers compensate for this problem by the accessibility with which the various types of water in the flow system can be sampled. From investigations of mostly the input-output chemistry, several hypotheses have been confirmed: (1) both unsaturated and supersaturated water occur in the vadose zone; (2) water discharging from the springs, even springs that drain regional-scale groundwater basins, are undersaturated with respect to calcite and dolomite; (3) although dilution and mixing effects dominate the

short time scale (days to weeks) fluctuations in spring-water chemistry, these variations are superimposed on an annual cycle controlled by rate of carbon dioxide generation and its seasonal variation; (4) the concept of a 'karst water type' or 'chemical facies' is confirmed; and (5) in a very approximate way, the chemical evolution of the conduit waters were traced through the system. Hardness increases along the flow path. In the sequence from the Haney Springs on the ridge top to the vertical shafts of the Mammoth Cave System, to the regional springs, the carbon dioxide pressure remained constant. In the sequence from the sinking streams at the southern margin of the Sinkhole Plain to the regional springs, the carbon dioxide partial pressure actually increased. Both sets of results imply carbon dioxide uptake along the flow path. (See also W90-08542) (Lantz-PTT)
W90-08548

2L. Estuaries

SIMULATING THE INDIRECT EFFECTS OF POWER PLANT ENTRAINMENT LOSSES ON AN ESTUARINE ECOSYSTEM.
Versar, Inc., Columbia, MD. Ecological Sciences and Analysis Div.
For primary bibliographic entry see Field 6G.
W90-07653

BACTERIAL PRODUCTION AND GROWTH RATE ESTIMATION FROM (H3)THYMIDINE INCORPORATION FOR ATTACHED AND FREE-LIVING BACTERIA IN AQUATIC SYSTEMS.
Universidad del Pais Vasco, Bilbao (Spain). Dept. de Microbiologia e Inmunologia.
For primary bibliographic entry see Field 7B.
W90-07692

EFFECTS OF ESTUARINE INFAUNA ON SEDIMENT STABILITY AND PARTICLE SEDIMENTATION.
Glasgow Univ. (Scotland). Dept. of Zoology.
For primary bibliographic entry see Field 2J.
W90-07720

SALINITY CHANGES IN CHARLESTON HARBOR 1922-1987.
South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.
B. Kjerfve, and K. E. Magill.
Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 116, No. 2, p 153-168, March/April 1990. 11 fig, 2 tab, 19 ref.

Descriptors: *Charleston Harbor, *Diversion, *Estuaries, *Salinity, *South Carolina, Cooper River, Model studies, Santee River, Stream discharge.

Charleston Harbor, South Carolina, has undergone pronounced changes in salinity regimes because of the diversion of the Santee River into the Cooper River in 1942 and rediversion of the Cooper into the Santee in 1985. The mean monthly harbor surface salinity changed from 30.1 ppt to 16.8 ppt as a result of the diversion, and has again increased to 22.0 since rediversion. Postdiversion monthly mean Cooper River discharge was 418 cu m/s, but since rediversion, the monthly mean discharge has decreased to 122 cu m/s and become less variable. Regression models for salinity variability in Charleston Harbor and Cooper River have been developed. Based on these models, discharge alone explains 78% of the salinity variance during the postdiversion period, but accounts for only 1% of the salinity variance after rediversion because of the near constant discharge. Thus, the estuary is presently much more susceptible to salinity changes due to far-field forcing from the coastal ocean. (Author's abstract)
W90-07733

MACROBENTHOS AND SEDIMENTARY ENVIRONMENTS IN A MALAYSIAN INTERTIDAL MUDFLAT OF THE COCKLE BED.
Hokkaido Univ., Hakodate (Japan). Faculty of

Fisheries.
S. Nakao, H. Nomura, and M. K. B. A. Satar.
Bulletin of the Faculty of Fisheries Hokkaido University HOSGAD, Vol. 40, No. 4, p 203-213, November 1989. 6 fig, 3 tab, 13 ref.

Descriptors: *Ecosystems, *Intertidal areas, *Mollusks, *Population dynamics, *Sediment distribution, *Species diversity, Mud flats, Polychaetes, Population density, Statistical analysis.

A quantitative survey (12 stations) of the intertidal soft bottom macrofauna in the Selangor River estuary of the peninsular Malaysian west coast was conducted during December, 1986. A total of 56 species were collected, polychaetes being the dominant group in species number (46.4%) and bivalve mollusks being the dominant group in population density (51.1%). The correspondence analysis performed with the abundance data of the most abundant species gave the ordination of three groups of stations (concordant with the cluster analysis performed with the abundance data of all species collected). The group 1 stations were distributed in the middle of the area surveyed and were dominated by the commercially important Anadara granosa and Diogenes sp. The group 2 stations, in the lower part of the estuary, were predominated by four species of polychaetes, and the group 3 stations were restricted to the upper part of the estuary and were dominated by one species of both the family Lyonsiidae and the family Ocypodidae. The ordination of stations by correspondence analysis (concordant with the cluster analysis) is fundamentally defined by coarse sand, medium sand, very fine sand and silt-clay percentage. Between the three faunal groups, significant differences in sedimentological variables were detected. Group 1 was found in the habitat with a high proportion of very fine sand to silt-clay, Group 2 was found in the area containing a relatively high proportion of coarse sand and medium sand to silt-clay and Group 3 was found in the habitat with a silty substratum. A suitable proportion of very fine sand to silt-clay and without a coarse sand fraction such as the distribution area of the Anadara type community. If the large number of Anadara granosa as the dominant species of this community type indicates a high survival of its spats, the sedimentary environment described here may be suitable for sowing cockle spats. (Author's abstract)
W90-07819

TRANSPORT PREDICTION IN PARTIALLY STRATIFIED TIDAL WATER.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
J. D. Wang, A. F. Blumberg, H. L. Butler, and P. Hamilton.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 380-396, March 1990. 38 ref, 4 append.

Descriptors: *Hydrodynamics, *Mathematical models, *Solute transport, *Tidal hydraulics, *Tidewater, Classification, Decision making.

The essentials of hydrodynamic model application techniques and necessary supporting data are given for the situation of a partially stratified water body. The presentation is aimed at improving numerical predictions of tidal hydrodynamics, and is oriented toward somewhat experienced modelers. The subjects are arranged in the order in which they ideally would be addressed during the execution of a study: hydrodynamic classification--on the basis of river flow, water surface elevations, wind, current, and salinity records; model selection--primarily dictated by its process-simulation capabilities and operational cost; model adaptation, model testing and calibration; and model verification and application. To encourage their use, it is recommended that providing a quantitative measure when comparing model data with observed data be a condition for publication. (Brunone-PTT)
W90-07831

INTERFACIAL MIXING DRIVEN BY MEAN SHEAR AND OSCILLATING GRID.
State Univ. of New York at Buffalo. Dept. of Civil

Engineering.
J. F. Atkinson, and S. B. Wolcott.
Journal of Hydraulic Engineering (ASCE)
JHEND8, Vol. 116, No. 3, p 397-414, March 1990.
5 fig, 25 ref, 2 append.

Descriptors: *Density stratification, *Energy
sources, *Mean shear, *Mixing, *Model studies,
*Oscillating grid, Entrainment, Mathematical
models, Shear tests.

Much work is done to understand the mixing proc-
esses at a density interface. Laboratory studies
commonly rely on experiments where entrainment
is driven by either a mean shear or a vertically
oscillating grid. Although these experiments pro-
vide useful results, neither of these setups is com-
pletely representative of conditions in natural
water bodies. A study was conducted to investi-
gate a more general situation where the relative
magnitudes of mixing generated by these two
sources of energy are varied in order to understand
better the differences in entrainment results report-
ed for the two different kinds of experiments. A
semiempirical model was developed, based primar-
ily on energy considerations, which accounts di-
rectly for the mixing energy introduced by wind,
friction or other energy sources. In particular, the
model directly incorporates the two sources of
mixing energy associated with the oscillating grid
and shear production. A major goal was to devel-
op a means of incorporating results from both
mean shear and grid experiments into a common
entrainment model, based primarily on energy con-
siderations. An advantage of the approach is, that
it is able to account for mean motions not necessar-
ily produced by wind. The main disadvantage is
that both mean and rms velocity values would
have to be measured in order to apply to the model
directly. In most field situations only the wind
velocity is known, from which the friction velocity
may be calculated and used to characterize the
transfer of energy at the air/water interface. The
friction velocity then becomes a convenient veloci-
ty scale for the entrainment model. The model
agrees well with the data and with the data from a
previous wind-mixing experiment. (Brunone-PTT)
W90-07832

**EFFECTS OF RIVER DISCHARGE AND HIGH-
TIDE STAGE ON SALINITY INTRUSION IN
THE WEEKI WACHEE, CRYSTAL, AND
WITHLACOOCHEE RIVER ESTUARIES,
SOUTHWEST FLORIDA.**
Geological Survey, Tampa, FL. Water Resources
Div.
D. K. Yobbi, and L. A. Knochenmus.
Available from Books and Open-File Report Sec-
tion, USGS, Box 25425, Denver, CO 80225. USGS
Water-Resources Investigations Report 88-4116,
October 1989. 75p, 40 fig, 11 tab, 29 ref.

Descriptors: *Crystal River, *Estuaries, *Florida,
*Saline water intrusion, *Weeki Wachee River,
*Withlacoochee River, Regression analysis.

The Weeki Wachee, Crystal, and Withlacoochee
Rivers are coastal streams flowing into the Gulf of
Mexico that may be affected by either future sur-
face water or groundwater withdrawals. Reduc-
tion of river discharge will affect the upstream
extent of saltwater intrusion in the rivers; however,
under certain reduced low-flow discharges, the
estimated change in upstream extent of saltwater
intrusion is on the order of several tenths of a mile
and frequently is within the range of predicted
error. Data on flow, tides, and salinity describe the
physical characteristics of the Weeki Wachee,
Crystal, and Withlacoochee River systems. Verti-
cal and longitudinal salinity profiles indicate that
salinity of the rivers increases downstream and
varies substantially at any given location. The
Weeki Wachee River system is the best mixed of
the three. The Crystal River system exhibited the
next best mixed system, and the Withlacoochee
River system exhibited the most variation in its
salinity regime. The daily maximum upstream
extent of salinity intrusion is described by multiple
linear-regression analysis based on daily mean
streamflow of each river and high-tide stage of the
gulf. The equations are used to show the effects of
discharge on the daily maximum upstream extent
of salinity intrusion in the rivers. (USGS)

W90-07842

**SIZE-SELECTIVE GRAZING ON BACTERIA
BY NATURAL ASSEMBLAGES OF ESTUA-
RINE FLAGELLATES AND CILIATES.**
Universidad del Pais Vasco, Bilbao (Spain). Dept.
de Microbiologia e Inmunologia.
J. M. Gonzalez, E. B. Sherr, and B. F. Sherr.
Applied and Environmental Microbiology
AEMIDF, Vol. 56, No. 3, p 583-589, March 1990.
4 fig, 3 tab, 35 ref. NSF Grants OCE-8700456 and
OCE-8823091.

Descriptors: *Estuaries, *Estuarine environment,
*Flagellates, *Marine bacteria, *Population dy-
namics, *Protozoa, Enteric bacteria, Microbiologi-
cal studies.

The small average cell size of in situ bacterioplank-
ton, relative to cultured cells, has been suggested
to be at least partly a result of selection of larger-
sized cells by bacterivorous protozoa. This study
determined the relative rates of uptake of fluores-
cence-labeled bacteria (FLB), of various cell sizes
and cell types, by natural assemblages of flagellates
and ciliates in estuarine water. Calculated clear-
ance rates of bacterivorous flagellates had a highly
significant, positive relationship with size of FLB,
over a range of average biovolume of FLB of 0.03
to 0.08 cu microns. Bacterial cell type or shape per
se did not appear to affect flagellate clearance
rates. The dominant size classes of flagellates
which ingested all types of FLB were 3-micron to
4-micron cells. Ciliates also showed a general pref-
erence for larger-sized bacteria. However, ciliates
ingested a gram-positive enteric bacterium and a
marine bacterial isolate at higher rates than they
did a similarly sized, gram-negative enteric bacteri-
um or natural bacterioplankton, respectively. From
the results of an experiment designed to test
whether the addition of a preferentially grazed
bacterial strain stimulated clearance rates of natu-
ral bacterioplankton FLB by the ciliates, it was
hypothesized that measured differences in rates of
FLB uptake were due instead to differences in
effective retention of bacteria by the ciliates. In
general, clearance rates for different FLB varied
by a factor of 2 to 4. Selective grazing by protozoa
of larger bacterioplankton cells, which are general-
ly the cells actively growing or dividing, may in
part explain the small average cell size, low fre-
quency of dividing cells, and low growth rates
generally observed for assemblages of suspended
bacteria. (Author's abstract)
W90-07864

**BACTERIOPLANKTON AND ORGANIC
CARBON DYNAMICS IN THE LOWER MESO-
HALINE CHESAPEAKE BAY.**
George Mason Univ., Fairfax, VA. Dept. of Biol-
ogy.
R. B. Jonas, and J. H. Tuttle.
Applied and Environmental Microbiology
AEMIDF, Vol. 56, No. 3, p 747-757, March 1990.
6 fig, 4 tab, 29 ref. NOAA Grant R1MG-DO-88-2.

Descriptors: *Aquatic bacteria, *Bacterioplankton,
*Chesapeake Bay, *Cycling nutrients, *Estuarine
environment, *Organic carbon, Biochemical
oxygen demand, Biomass, Nitrogen, Organic
matter, Oxygen balance, Phytoplankton, Seasonal
variation.

The mesohaline portion of the Chesapeake Bay is
subject to annual summertime hypoxia and anoxia
in waters beneath the pycnocline. The dissolved
oxygen deficit is directly related to salinity-based
stratification of the water column in combination
with high levels of autochthonously produced or-
ganic matter and a very high abundance of meta-
bolically active bacteria. Throughout the water
column in the lower, mesohaline part of the bay,
between the Potomac and Rappahannock rivers,
near the southern limit of the mainstem anoxia,
bacterial abundance often exceeded 1 million cells
per ml and bacterial production exceeded 7 billion
cells/L/day during the summer. Bacterial biomass
averaged 34% (range, 16-126%) of the phytoplank-
ton biomass in summer. These values are equal to
or greater than those found farther north in the
bay, where the oxygen deficit is more severe.

Seasonal variations in bacterial abundance and pro-
duction were correlated with phytoplankton bio-
mass (lag time, 7-14 days), particulate organic
carbon and nitrogen, and particulate biochemical
oxygen demand (BOD) in spring; but during
summer, they were significantly correlated only
with dissolved BOD. During summer, dissolved
BOD can account for 50-60% of the total BOD
throughout the water column and 80% in the
bottom waters. There is a clear spring-summer
seasonal shift in the production of organic matter
and in the coupling of bacteria and autochthonous
organic matter. The measurement of dissolved,
microbially labile organic matter concentrations is
crucial in understanding the trophic dynamics of
the lower mesohaline part of the bay. The absolute
levels of organic matter in the water column and
the bacterial-organic carbon relationships suggest
that a lower bay source of organic matter fuels the
upper mesohaline bay oxygen deficits. (Author's
abstract)
W90-07867

**EPIPHYTE COMMUNITY OF MANGROVE
ROOTS IN A TROPICAL ESTUARY: DISTRI-
BUTION AND BIOMASS.**
Center for Energy and Environment Research,
Mayaguez, PR.
C. Rodriguez, and A. W. Stoner.
Aquatic Botany AQBODS, Vol. 36, No. 2, p 117-
126, February 1990. 2 fig, 5 tab, 19 ref. NOAA
Grant R/A-01-2; NSF Grant R-II-8610677.

Descriptors: *Epiphytes, *Estuaries, *Estuarine
environment, *Mangrove swamps, Biomass,
Laguna Joyuda, Leaf litter, Puerto Rico, Roots,
Species diversity.

The algal community associated with roots of the
red mangrove (Rhizophora mangle), bordering
Laguna Joyuda estuary in Puerto Rico was investi-
gated during June and July 1986. With a total of 8
macroalgal species collected, species richness in
the lagoon was low relative to other mangrove
epiphyte communities in the Caribbean. The varia-
tion in species composition and biomass was relat-
ed to distance from shore, distance from the la-
goon's inlet, freshwater sources and degree of shel-
ter. A total algal biomass for the lagoon of 74,200
kg dry weight (DW) was similar to the total annual
leaf litterfall from the Rhizophora fringe (93,100
DW), explaining the dominance of algal food webs
in Laguna Joyuda. (Author's abstract)
W90-07871

**YEAR-TO-YEAR VARIATION IN PEAK
ABOVE-GROUND BIOMASS OF SIX SALT-
MARSH ANGIOSPERM COMMUNITIES AS
RELATED TO RAINFALL DEFICIT AND IN-
UNDATION FREQUENCY.**
Delta Inst. for Hydrobiological Research, Yerseke
(Netherlands).
J. de Leeuw, H. Olff, and J. P. Bakker.
Aquatic Botany AQBODS, Vol. 36, No. 2, p 139-
151, February 1990. 3 fig, 4 tab, 50 ref.

Descriptors: *Aquatic plants, *Drought, *Saline
soils, *Salt marshes, *Spartina, *Wetlands, Bio-
mass, Salinity, Seasonal variation, Soil water.

Peak above-ground biomass of 6 annually mown
salt-marsh angiosperm communities was measured
over a 13-year period. Top soil salinity and soil
moisture content in the 6 communities were meas-
ured during two dry years. Over the 13-year
period the communities showed a synchronous pat-
tern in peak biomass. Year-to-year variation in this
biomass could be explained by the rainfall deficit
during the growing season, while inundation fre-
quency did not contribute to the regression model.
Higher shoot densities have been reported for
Spartina alterniflora following irrigation with
freshwater, but above-ground biomass was not in-
creased. This lack of response to S. alterniflora
marshes to irrigation may be related to the fact that
they occur between mean high water and mean
low water level, whereas the marshes studies are
located well above the mean high water level. At
tidal elevations below mean high water, fluctua-
tions in soil salinity are strongly related to the

salinity of the inundation waters and not to the rainfall deficit prior to soil sampling. A reversal of these relationships occurs above the mean high water level. Hence the influence of the rainfall deficit during the growing season on the above-ground biomass accumulated would increase with tidal elevation, upper marshes being more sensitive than lower marshes. This is confirmed by the high coefficient of variation of peak above-ground biomass reported in this study (31-62%) compared with the low value (9.1% estimated from a graph) reported for S. alterniflora marshes studied over a 13-year period. Climatically induced year-to-year variation in soil conditions was held responsible for the observed year-to-year variation in peak above-ground biomass. (Sand-PTT)
W90-07872

EFFECTS OF NUTRIENT AND LITTER MANIPULATIONS ON THE NARROW-LEAVED CATTAIL, TYPHA ANGUSTIFOLIA L.
Smithsonian Environmental Research Center, Edgewater, MD.
T. E. Jordan, D. F. Whigham, and D. L. Correll.
Aquatic Botany AQBODS, Vol. 36, No. 2, p 179-191, February 1990. 4 fig, 1 tab, 48 ref. NSF grant BSR-8316948.

Descriptors: *Cattails, *Cycling nutrients, *Litter, *Nitrogen, *Phosphorus, *Tidal marshes, *Wetlands, Ammonium phosphate, Biomass, Insect infestation, Salinity.

The effects of altering litter and nutrient loading on above-ground production, nutrient content and borer infestation of Typha angustifolia were studied with a 3-year field experiment. In replicated plots, litter was either removed, replaced with plastic strips (pseudolitter), increased 3-fold or left unaltered. One set of plots received fortnightly surface applications of ammonium phosphate solution at a rate totaling 65 g N/sq m and 72 g P/sq m annually. Peak above-ground biomass was increased by nutrient addition, except in the third year of the experiment when peak biomass in all plots was low, possibly due to high salinity that year. The nutrient additions also decreased the rate of flowering, increased concentrations of N and P in plant tissues, and increased the frequency of shoot infestation by boring noctuid larvae. The effects of the litter manipulations seem to be attributable to the physical structure of the litter layer rather than the decomposition process. Plots with neither litter nor pseudolitter showed enhanced incorporation of added N and P in fruits, and were colonized by the herbaceous dicotyledons Lilaeopsis chinensis and Pluchea purpurascens. Plots receiving extra litter developed a litter layer thick enough to suppress the growth of Typha in the third year. (Author's abstract)
W90-07873

FLUORITE IN RECENT SEDIMENTS AS A TRAP OF TRACE METAL CONTAMINANTS IN AN ESTUARINE ENVIRONMENT.
Israel Oceanographic and Limnological Research Ltd., Haifa.
For primary bibliographic entry see Field 5B.
W90-07887

TIDAL PROGRESSION IN A NEAR-RESONANT SYSTEM—A CASE STUDY FROM SOUTH AUSTRALIA.
University Coll. of North Wales, Menai Bridge. School of Ocean Sciences.
D. G. Bowers, and G. W. Lennon.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 1, p 17-34, January 1990. 7 fig, 5 tab, 9 ref.

Descriptors: *Australia, *Estuaries, *Gulfs, *Tidal amplitude, *Tides, Bays, Case studies, Energy transfer, Friction, Gulf St Vincent, Mathematical models.

Detailed observations were made of the tide in a shallow Southern Hemisphere gulf, the Gulf St. Vincent, a negative or inverse estuary serving Adelaide, Australia. The gulf is close to quarter-wave resonance with the semi-diurnal tide, but the

nature of the tide changes with distance from the head of the gulf. Near the head, the tide behaves as a standing wave: the phase is almost constant in this region and the tidal currents lead elevations by 90 deg. Near the entrance to the gulf, the semi-diurnal tide behaves more as a progressive wave: there is a regular change in phase of elevation with distance and the phase difference between current and elevation is reduced. It was shown here that this behavior can be understood in terms of a simple conceptual model whereby friction causes the amplitude of the tidal wave to diminish exponentially with distance travelled. Near the gulf head, the incident and reflected waves are of similar amplitude, and a standing wave is produced. Further from the head, the incident wave is considerably larger then the reflected wave and the resulting wave is predominantly progressive. The observations presented are in good agreement with this model if the tidal wave amplitude is allowed to fall by 1/e for every wavelength travelled. This decay in wave amplitude implies a rate of energy loss in the region (for the M2 tide) of 135 MW, a figure which is consistent with an independent estimate of energy dissipation. (Geiger-PTT)
W90-07888

PRIMARY PRODUCTIVITY OF ANGIOSPERM AND MACROALGAE DOMINATED HABITATS IN A NEW ENGLAND SALT MARSH: A COMPARATIVE ANALYSIS.
Rutgers - The State Univ., New Brunswick, NJ. Center for Coastal and Environmental Studies.
C. T. Roman, K. W. Able, M. A. Lazzari, and K. L. Heck.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 1, p 35-45, January 1990. 2 fig, 3 tab, 32 ref.

Descriptors: *Algae, *Macrophytes, *Marsh plants, *Nauset Marsh, *Primary productivity, *Salt marshes, *Wetlands, Biomass, Comparison studies, Habitats, Intertidal areas, Massachusetts, Mud flats.

Net primary productivity estimates were made for the major macrophyte dominated habits of the Nauset Marsh system, Cape Cod, Massachusetts. Above-ground primary productivity of short form Spartina alterniflora, the dominant habitat of the system, was 664 gm/sq m/yr. Productivity of the other dominant angiosperm (Zostera marina) was estimated to range from 444-987 gm/sq m/yr. The marsh creekbank habitat was dominated by an intertidal zone of fucoid algae (Ascophyllum nodosum ecad. scorpioides, 1179 gm/sq m/yr; Fucus vesiculosus, 426 gm/sq m/yr), mixed intertidal filamentous algae (91 gm/sq m/yr), and a subtidal zone of assorted macroalgae (68 gm/sq m/yr). Intertidal mudflats were dominated by Cladophora gracilis, with net production ranging from 59-637 gm/sq m/yr. These angiosperm and macrophyte dominated habitats produce over 3 million kg/yr of biomass (1.2 million kg carbon/yr). Twenty-eight percent of this carbon production is derived from the Zostera and macroalgae habitats. Although S. alterniflora is considered the major macrophyte primary producer in Nauset Marsh and other north temperate salt marshes, it is concluded that other habitats also contribute significantly to total system carbon production. (Author's abstract)
W90-07889

METAL CONCENTRATIONS IN TISSUES OF SPARTINA ALTERNIFLORA (LOISEL.) AND SEDIMENTS OF GEORGIA SALT MARSHES.
Georgia Univ., Sapelo Island. Marine Inst.
For primary bibliographic entry see Field 5B.
W90-07890

PETROLEUM HYDROCARBONS IN THE SURFACE WATER OF TWO ESTUARIES IN THE SOUTHEASTERN UNITED STATES.
South Carolina Univ., Columbia. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W90-07891

EXPERIMENTAL STUDIES ON THE SURVIVAL OF FECAL BACTERIAL FROM URBAN

SEWAGE IN SEAWATER (ETUDE EXPERIMENTALE DE LA DECROISSANCE DES BACTERIES FECALES EN MILIEU MARIN QUANTIFICATION, FACTEURS IMPLIQUES).
Fondation Oceanographique RICARD, BP 39, 13762 Les Milles Cedex, France.
For primary bibliographic entry see Field 5B.
W90-07907

APPLICATION OF THE COMMUNITY DEGRADATION INDEX TO SOUTH AFRICAN ESTUARIES.
National Inst. for Water Research, Congella (South Africa). Natal Regional Lab.
For primary bibliographic entry see Field 5C.
W90-07924

RELATIONSHIP BETWEEN FEEDING INCIDENCE AND VERTICAL AND LONGITUDINAL DISTRIBUTION OF RAINBOW SMELT LARVAE (OSMERUS MORDAX) IN A TURBID WELL-MIXED ESTUARY.
Laval Univ., Quebec. Dept. de Biologie.
J. Dauvin, and J. J. Dodson.
Marine Ecology Progress Series MESEDT, Vol. 60, No. 1/2, p 1-12, February 1990. 4 fig, 7 tab, 17 ref.

Descriptors: *Estuaries, *Feeding rates, *Fish populations, *Smelt, Fish food organisms, Larvae, Life history studies, Population density, Predation, Size classes, Spatial distribution, St Lawrence Estuary, Turbidity, Vertical distribution, Zooplankton.

The hypothesis that the active vertical migration of the larvae of anadromous rainbow smelt (Osmerus mordax) observed in the turbid, well-mixed portion of the St. Lawrence Estuary is an adaptation to improve feeding incidence by retaining larvae in productive, up-estuary waters was tested. The vertical distribution, diet, and feeding incidence of larvae of three length classes over four tidal cycles at each of 3 stations located along the longitudinal axis of the upstream portion of the estuary was documented. The percentage of smelt larvae with gut contents increased with larval length and with distance upstream for all three length classes. Vertical migrations of larvae were not related to feeding incidence in the vertical plane, except in the case of the smallest length class, indicating that active vertical migrations were not behavioral responses to vertical changes in prey availability. The predominance of calanoid copepods and freshwater cladocerans in the diets of larvae with the highest feeding frequencies and the predominance of mysids in the diets of larvae with the lowest feeding frequencies suggested that larvae were more successful feeding on copepods and cladocerans than on the larger mysids. Apparent tidal rhythmicity in diet and feeding success was largely due to the tidal displacement of water masses at fixed sampling stations. Feeding incidence at the two sampling stations situated within the maximum turbidity zone was greatest in larvae advected from upstream at the end of ebbing tide. It was concluded that active vertical migration of smelt larvae is an adaptation to maximize the longitudinal retention of high densities of larvae in a zone of high prey biomass. (Author's abstract)
W90-07938

UTILIZATION OF FLOATING MANGROVE LEAVES AS A TRANSPORT MECHANISM OF ESTUARINE ORGANISMS, WITH EMPHASIS ON DECAPOD CRUSTACEA.
Hamburg Univ. (Germany, F.R.). Zoologisches Inst. und Zoologisches Museum.
I. S. Wehrtmann, and A. I. Dittel.
Marine Ecology Progress Series MESEDT, Vol. 60, No. 1/2, p 67-73, February 1990. 5 fig, 2 tab, 38 ref.

Descriptors: *Crustaceans, *Ecosystems, *Mangrove trees, *Population dynamics, *Species composition, Costa Rica, Larvae, Migration, Predation, Recruitment, Tides.

Floating mangrove leaves with associated organisms were sampled approximately every two

hours over four consecutive tidal cycles from 1 to 3 December 1987 in the estuary of Punta Morales, Gulf of Nicoya, Costa Rica. Crabs were the predominant animals collected (77.8%), followed by shrimps, fishes, and other crustaceans. The four most abundant decapod crustacean taxa found attached to the leaves were Uca, Callinectes, Penaeus, and Macrobrachium. Megalopal and juvenile stages of decapods, clingfish, Tomicodon sp., as well as amphipods and isopods, were attached to the drifting leaves. Organisms were significantly more numerous during flood than ebb; mean total number of individuals per leaf was one order of magnitude greater during incoming than during outgoing tide (2.3 versus 0.1). This transport mechanism may minimize both the risk of predation and the energy required to immigrate into the preferred habitat. This strategy may be important for recruitment of crabs and shrimps in mangrove ecosystems. (Author's abstract)
W90-07940

EFFECT OF VARIABLE NUTRIENT SUPPLY ON FATTY ACID COMPOSITION OF PHYTOPLANKTON GROWN IN AN ENCLOSED EXPERIMENTAL ECOSYSTEM.
Institut National de la Recherche Scientifique, Rimouski (Quebec). Centre d'Oceanologia.
P. Mayzaud, H. Claustre, and P. Augier.
Marine Ecology Progress Series MESEDT, Vol. 60, No. 1/2, p 123-140, February 1990. 9 fig, 8 tab, 39 ref.

Descriptors: *Algal growth, *Ecosystems, *Estuarine environment, *Limiting nutrients, *Phytoplankton, *Plant physiology, Acclimation, Fatty acids, Plant nutrients, Species composition, Zooplankton.

Outdoor experimental tanks were used to simulate phytoplankton blooms in natural seawater from the bay of Villefranche-sur-Mer (France) during March-April 1984. External temperature and light intensity were respectively monitored every 4 hours and light. Nutrient conditions were followed daily and maintained by a cycle of dilutions with fresh enriched seawater. Six different cycles of phytoplankton production were followed. They differed by the dilution rates used. Nutrient uptake, phytoplankton composition, biochemical composition and detailed lipid composition of the phytoplankton were followed throughout each growth cycle. Results showed a clear difference between the first cycle, which lasted 7 days, and subsequent ones, which lasted only from 27 to 51 hours. In terms of species composition, the initial body of water comprised a complex assemblage of species (flagellates, diatoms, dinoflagellates, microzooplankton) which were gradually replaced by a community of diatoms. Total fatty acid changes reflected the progressive changes in species composition and to a minor extent the nutrient regime. Nutrient regime affected essentially the neutral lipid composition while changes in physiological state were reflected in the polar lipid composition. Probable light limitation during the fourth growth cycle may explain some of the changes in the fatty acid composition. In all cases, transient saturation-desaturation processes of the membrane lipids seems at the heart of the acclimation dynamics. (Author's abstract)
W90-07941

CHANGES IN HARD BOTTOM COMMUNITIES RELATED TO BOAT MOORING AND TRIBUTYLTIN IN SAN DIEGO BAY: A NATURAL EXPERIMENT.
Moss Landing Marine Labs., CA.
For primary bibliographic entry see Field 5C.
W90-07942

EVIDENCE FOR SEDIMENTING PARTICLES AS THE ORIGIN OF THE MICROBIAL COMMUNITY IN A COASTAL MARINE SEDIMENT.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
For primary bibliographic entry see Field 2J.
W90-07943

MULTIVARIATE APPROACHES TO THE VARIATION IN PHYTOBENTHIC COMMUNITIES AND ENVIRONMENTAL VECTORS IN THE BALTIC SEA.
Stockholm Univ. (Sweden). Dept. of Zoology.
H. Kautsky, and E. van der Maarel.
Marine Ecology Progress Series MESEDT, Vol. 60, No. 1/2, p 169-184, February 1990. 8 fig, 2 tab, 80 ref.

Descriptors: *Baltic Sea, *Benthic environment, *Benthic flora, *Ecosystems, *Multivariate analysis, Biomass, Bottom topography, Distribution patterns, Performance evaluation, Species composition, Water depth, Wave exposure.

Quantitative data on plant and animal distribution, biomass and environmental data from vegetation-covered bottoms in the northern Baltic proper are analyzed with numerical methods used in modern terrestrial vegetation analysis. The main aim of these multivariate analyses is to correlate environmental factors with detected patterns of species distribution. As the material had already been analyzed by conventional techniques, an evaluation of the multivariate analyses was possible. They proved to be of good help in interpreting large data sets from phytobenthic communities. The analyses stress the importance of depth, bottom type, and wave exposure, in order of decreasing importance, as the major factors ruling the observed zonation pattern. In contrast with true marine ecosystems, biotic interactions seem to be of minor importance for the establishment of large-scale zonation of phytobenthos in the Baltic Sea. (Author's abstract)
W90-07944

BENTHIC INVERTEBRATE COMMUNITY OF A SOUTHERN CAPE ESTUARY: STRUCTURE AND POSSIBLE FOOD SOURCES.
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
A. K. Whitfield.
Transactions of the Royal Society of South Africa TRSAAC, Vol. 47, No. 2, p 159-179, December 1989. 5 fig, 5 tab, 58 ref.

Descriptors: *Benthic fauna, *Ecosystems, *Ecotypes, *Estuaries, *Food chains, *Invertebrates, *Species composition, Algae, Biodegradation, Biomass, Cluster analysis, Detritus, Gut content analysis, Microorganisms, Mollusks, Sea grasses, South Africa.

Cluster analysis of invertebrate communities in the Swartvlei estuary revealed that vegetated (Zostera capensis) sites were distinct from unvegetated ones. Indicator species for the eelgrass group included Melita zeylinaca, Loripes clausus, Natica tecta, and Palaemon pacificus, whereas those for bare sand community were Urothoe pulchella, Callianassa kraussi, Iphinoe truncata, and Pontogeloides latipes. Infaunal bivalves comprised over 60% of the invertebrate biomass at Zostera sites but less than 5% at bare sand sites. Conversely, the infaunal anomuran Callianassa dominated the sandy sites and was a minor component of the vegetated sites. The supratidal invertebrate community was dominated by Orchestia spp., which live and feed on wrack detritus. Litterbag experiments revealed that degradation of Zostera leaf wrack was rapid during the first thirty days after deposition but slow between 40 and 140 days. Laboratory experiments indicated that Orchestia consumption of wrack material could not account for the rapid weight loss recorded in the natural environment. Preliminary diet analyses of intertidal and infratidal zoobenthos revealed that most invertebrate species feed on detritus and associated microorganisms. Filamentous algae and diatoms dominated the gut contents of only three out of 18 macrobenthic species, and living Zostera was not an important food item for any invertebrate examined. (Author's abstract)
W90-07949

BACTERIOPLANKTON IN FILTERED BRACKISH WATER CULTURES: SOME PHYSICAL AND CHEMICAL PARAMETERS AFFECTING COMMUNITY PROPERTIES.
Tvarminne Zoological Station (Finland).
R. M. Autio.
Archiv fuer Hydrobiologie AHYBA4, Vol. 117, No. 4, p 437-451, February 1990. 3 fig, 2 tab, 33 ref.

Descriptors: *Aquatic bacteria, *Brackish water, *Light penetration, *Marine environment, *Nitrogen, *Nutrients, *Phosphorus, *Plankton, *Temperature effects, Growth, Gulf of Finland, Population dynamics.

Brackish-water batch cultures taken from the Hanko archipelago at the entrance to the Gulf of Finland were used to investigate the effect of temperature, light and nutrients (nitrogen, phosphorus) on bacterioplankton. Three factorial experiments were performed in April and September 1988, to study the effects of treatments on bacterial abundance and heterotrophic secondary production. Factors for converting thymidine incorporation into cell production and generation times were calculated. The conversion factors ranged between 1.0 and 21.8 billion cells/nanomoles H3 incorporated and the generation times from 15.5 to over 300 hr. Cell volumes were also measured. Temperature was the most important factor regulating both cell abundance and thymidine incorporation. The low temperature (< 1 C) seemed to prevent bacterial cells from growing or producing. The higher temperature (15 C) increased thymidine incorporation and cell growth. Neither addition of nutrients nor the light treatment had any significant effect. (Author's abstract)
W90-07957

RAINFALL AND SALINITY OF A SAHELIAN ESTUARY BETWEEN 1927 AND 1987.
Centre de Recherches Oceanographiques de Dakar-Thiaroye (Senegal).
J. Pages, and J. Citeau.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 325-341, February 1990. 8 fig, 3 tab, 41 ref, append 2.

Descriptors: *Estuaries, *Rainfall-runoff relationships, *Salinity, *Senegal, Arid-zone hydrology, Evaporation, Hydrologic budget, Sahel.

The Saloum River (Senegal, West Africa) is an inverse estuary, with salinities of > 80 g/L reached 100 km from the sea. Monthly salinity measurements have been done 120 km inland since 1927. Seasonal salinity increase (during dry season) proceeds at a constant rate (about 0.3 g/L/d). This would indicate that evaporating water masses are shallow (average depth about 0.4 m). Since 1950, annual maximum and minimum salinities have been increasing, with decreasing rains, at a rate of about 1.3 g/L per year. Across the 1927-1987 period, both yearly extremes are well correlated with rainfall in the previous years, indicating a 'memory' spanning three years or less. A water budget is computed as a function of rainfall, with three different hypotheses, about the extent of the evaporating surfaces. Comparison with actual data indicate that about 60% of the lowlands are evaporating as shallow open waters would. (Author's abstract)
W90-07993

ASSOCIATION BETWEEN EXUDATES OF BROWN ALGAE AND POLYCHLORINATED BIPHENYLS.
Alfred-Wegener-Inst. fuer Polarforschung, Bremerhaven (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W90-08002

COUNTING ERROR AND THE QUANTITATIVE ANALYSIS OF PHYTOPLANKTON COMMUNITIES.
Instituto de Ciencias del Mar, Barcelona (Spain).
For primary bibliographic entry see Field 7C.
W90-08009

HYDRODYNAMIC TRAPPING IN THE FORMATION OF THE CHLOROPHYLL A PEAK

Group 2L—Estuaries

IN TURBID, VERY LOW SALINITY WATERS OF ESTUARIES.
Old Dominion Univ., Norfolk, VA.
C. Moon, and W. M. Dunstan.
Journal of Plankton Research JPLRD9, Vol. 12, No. 2, p 323-336, March 1990. 5 fig, 4 tab, 41 ref.

Descriptors: *Brackish water, *Chlorophyll a, *Diatoms, *Estuaries, *Tidal hydraulics, *Turbidity, Biomass, Flow discharge, Food chains, Geochemistry, James River, Nitrogen compounds, Organic carbon, Phytoplankton, Pigments, Seasonal variation, Silica, Sinking rates, Upward water velocity.

In the James River Estuary, a chlorophyll peak occurred in very low salinity waters (0.5 ppt) during periods of low river discharge in the summer and fall. The biomass of phytoplankton, as measured by chlorophyll concentration, was 5-10 times that formed in adjacent areas further upstream and downstream. Comparisons between the peak area and the 2 ppt area for net plankton biomass, biogenic silica, phaeopigments, particulate organic carbon/particulate organic nitrogen ratios and microscopic observation indicated the peak biomass was largely composed of high concentrations of physiologically healthy freshwater diatoms. Equations were applied for particle sinking rates to diatoms observed in the James River and these rates were compared with calculations of upward vertical water velocity. During periods of low river discharge (summer and fall) the sinking rate of diatoms in the chlorophyll peak closely balanced the net upward water velocity, thereby selectively trapping diatoms in the very low salinity zone. The turbidity maximum increased in intensity and moved downriver in winter and spring due to high river discharge. As upward water velocity increases, phytoplankton are never able to attain a critical biomass and are swept downestuary. This seasonally changing plant biomass is significant to food chain and geochemical considerations of estuaries. (Author's abstract)
W90-08010

NEW TYPE OF ZOOPLANKTON SAMPLER.
Biological Inst., Dubrovnik (Yugoslavia).
For primary bibliographic entry see Field 7B.
W90-08011

EVALUATION OF CLAMSHELL DREDGING AND BARGE OVERFLOW, MILITARY OCEAN TERMINAL, SUNNY POINT, NORTH CAROLINA.
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 6G.
W90-08139

HEAVY METALS, CARBON AND HYDROCARBONS IN THE SEDIMENTS OF TABLE BAY HARBOUR.
Sea Fisheries Research Inst., Cape Town (South Africa).
For primary bibliographic entry see Field 5B.
W90-08161

INTERFACIAL MIXING IN ESTUARIES AND FJORDS.
Polytechnic of Wales, Pontypridd. Dept. of Civil Engineering.
J. P. Grubert.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 2, p 176-195, February 1990. 5 fig, 2 tab, 46 ref, append.

Descriptors: *Density stratification, *Estuaries, *Fjords, *Mathematical models, *Model studies, *Saline-freshwater interfaces, *Stratified flow, Critical flow, Diffusion, Entrainment, Mathematical studies, Mixing, Rapid flow, Turbulent flow, Wave action.

Mathematical modelers of stratified flows in estuaries and fjords need to include in their equations terms representing the transfer of fluid across the density interface. Using a combination of results obtained from theory and laboratory and field measurements, it was found that two distinct types of interfacial mixing can be identified. When the interfacial transition layer is in a subcritical state, mixing takes place in either direction to a greater or lesser extent, depending on the turbulence in each layer. This type of mixing is called entrainment and is due to Kelvin-Helmholtz instabilities. When the interfacial transition layer is in a critical or supercritical state, a two-way transfer process called turbulent-diffusion mixing takes place. In this condition, violent vortex motions, generated by internal wave interference, exchange equal volumes of fluid between the layers. The resulting equations were compared with the results of other researchers and found to have similar characteristics. (Author's abstract)
W90-08208

CHRONIC TRIBUTYLTIN TOXICITY EXPERIMENTS WITH THE CHESAPEAKE BAY COPEPOD, ACARTIA TONSA.
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
For primary bibliographic entry see Field 5C.
W90-08247

ARSENIC UPTAKE AND TRANSFER IN A SIMPLIFIED ESTUARINE FOOD CHAIN.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 5B.
W90-08250

COMPUTING PHASE SPEEDS AT OPEN BOUNDARY.
Institute for Naval Oceanography, Stennis Space Center, MS.
L. H. Kantha, A. F. Blumberg, and G. L. Mellor.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 592-597, April 1990. 3 fig, 10 ref.

Descriptors: *Boundary conditions, *Hydrologic models, *Model studies, *Wave velocity, *Waves, Bays, Estuaries, Mathematical analysis, Phase speeds.

The principal problem in modeling an estuary or a bay, a limited region of an ocean basin such as the coastal waters, or a mesoscale atmospheric domain, is with the treatment of the open boundaries. Among the many boundary conditions proposed, the Sommerfeld radiation condition appears the most appealing. Since calculation of the phase speed of the wave is important when using the radiation condition, simulations in a frictionless, nonrotating, one-dimensional channel have been conducted, using linear shallow water wave equations, to investigate how best to compute the phase speed of a wave that is impinging on an open boundary. First time series of long wave phase speeds were calculated four different ways at the same distance from forcing boundary. Long wave phase speeds were also calculated and used in conjunction with the Sommerfeld radiation condition. To eliminate spikes in the computed phase speed, a recursive filter was used. Results showed that a phase speed obtained using the recursive filter is reliable and minimized the distortion of the wave form. (VerNooy-PTT)
W90-08260

LONG-TERM MONITORING OF THE EFFECTS OF TREATED SEWAGE EFFLUENT ON THE INTERTIDAL MACROALGAL COMMUNITY NEAR CAPE SCHANCK, VICTORIA, AUSTRALIA.
Melbourne and Metropolitan Board of Works (Australia). Environmental Services Section.
For primary bibliographic entry see Field 5C.
W90-08263

NUMERICAL SIMULATIONS OF BLUE CRAB LARVAL DISPERSAL AND RECRUITMENT.
Minerals Management Service, Herndon, VA. Environmental Studies Branch.
D. F. Johnson, and K. W. Hess.
Bulletin of Marine Science BMRSAW, Vol. 46, No. 1, p 195-213, January 1990. 9 fig, 4 tab, 50 ref, 2 append.

Descriptors: *Bays, *Chesapeake Bay, *Crabs, *Model studies, Crustaceans, Dispersion, Flow, Larvae, Virginia, Water circulation, Water currents, Wind-driven currents.

Wind-induced and current-induced drifts of blue crab larvae hatching near the mouth of Chesapeake Bay, Virginia, were simulated using numerical models to examine the relationship between larval recruitment and environmental forcing. The circulation is produced with a three-dimensional model of the bay and adjacent continental shelf. The circulation is then used by a drifter advection model to produce Lagrangian drift tracks. Observed winds at Norfolk, Virginia, predicted tides from harmonic analysis, and daily river discharges from major tributaries are used as driving forces. The model includes both density and wind forced circulation. Also modelled was the release of near-surface drifters from 132 hatch locations in and near the bay mouth. Because higher numbers of larvae have been observed at some locations, each location of a simulated hatch is given a probability weighting. Model hatches occur on three different days in both 1980 and 1982, and drifters are tracked for 45 days. At the end of that time, the location of each drifter is analyzed. Those within the bay are categorized as recruited. Weighted recruitment ranges from 3 to 67%, with a mean of 42% of the total larvae. Although in the simulations some larvae are retained in the bay and never leave (averaging 13%), a majority of larvae leave the bay (87%) and a large number (29%) leave the bay and later return in the surface waters. In cases where drifters are moved to the bottom after 35 days, subsequent recruitment is severely reduced. By alternately removing forcing by winds, river flow, and density differences, the relative influence of the three forcings is also evaluated. The wind component is found to have the greatest effect on larval recruitment, although wind can either increase or decrease recruitment. River flow and gravitational circulation each have a smaller influence. (Author's abstract)
W90-08264

LEVELS OF PB, CR AND CD IN CALLINECTES SAPIDUS AND C. SIMILIS AND THEIR RELATION TO THE CONCENTRATION OF THESE METALS IN WATER AND IN SEDIMENT (NIVELES DE PB, CR Y CD EN CALLINECTES SAPIDUS Y C. SIMILIS Y SU RELACION CON LA CONCENTRACION DE ESTOS EN EL AGUA Y EN EL SEDIMENTO).
Universidad Autonoma Metropolitana, Mexico City. Lab. de Contaminacion, Bioensayos e Impacto Ambiental.
For primary bibliographic entry see Field 5B.
W90-08281

SAPROBIC CLASSIFICATION OF A HIGHLY-CONTAMINATED CUBAN ESTUARY (CLASSIFICACION SAPROBIOTICA DE UN ESTUARIO CUBANO ALTAMENTE CONTAMINADO).
Universidad de la Habana (Cuba). Dept. de Zoologia.
For primary bibliographic entry see Field 5C.
W90-08282

PROCESSES OF MARINE DISPERSAL AND DEPOSITION OF SUSPENDED SILTS OFF THE MODERN MOUTH OF THE HUANGHE (YELLOW RIVER).
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 2J.
W90-08323

MECHANISMS OF WATER STORAGE IN SALT MARSH SEDIMENTS: THE IMPORTANCE OF DILATION.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2G.
W90-08324

HUMMOCKY CROSS-STRATIFICATION AND POST-VORTEX RIPPLES: LENGTH SCALES AND HYDRAULIC ANALYSIS.
University of Southern California, Los Angeles.
Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-08378

COAGULATION AND TRANSPORT OF SEDIMENTS IN THE GIRONDE ESTUARY.
Delaware Univ., Newark. Center for Colloidal Science.
R. J. Gibbs, D. M. Tshudy, L. Konwar, and J. M. Martin.
Sedimentology SEDIAT, Vol. 36, No. 6, p 987-999, December 1989. 12 fig, 56 ref.

Descriptors: *Coagulation, *Estuaries, *Estuarine sediments, *France, *Gironde Estuary, *Hydrodynamics, *Sediment transport, *Turbidity, Data acquisition, Data interpretation, Flocs.

The distribution of suspended particle size and concentration were measured along the Gironde Estuary, France, from the river seaward to the ocean. The suspended particle size and volume concentration were measured using in situ holography and onboard techniques utilizing special procedures in order to avoid floc breakage. Sediments discharged by the rivers coagulate upon encountering the very low salinities (0.2 ppt) of the upper estuary (confirmed with laboratory experiments), and are then transported and deposited by currents in the reminder of the estuary. This coagulation, coupled with estuarine circulation, produces a turbidity maximum which is offset between the surface and bottom waters. The floc size maximum is oceanward of the turbidity maximum and is, likewise, offset along the estuary by about 30 km. The estuary can be subdivided into the following zones: (1) coagulation; (2) hydrodynamic, landward of the null point; and (3) hydrodynamic, seaward of the null point. Initial coagulation appears to be completed in coagulation zone (1), and particles are transported and settled (with very little floc breakage and recoagulation) in zones (2) and (3) only. The floc settling velocities, coupled with estuarine circulation, control the concentration and size distributions of flocs in the water column, and eventually control the deposition of sediments. (Author's abstract)
W90-08379

INCIDENCE OF UREA-HYDROLYZING VIBRIO PARAHAEMOLYTICUS IN WILLAPA BAY, WASHINGTON.
Food and Drug Administration, Bothell, WA. Seafood Products Research Center.
For primary bibliographic entry see Field 5B.
W90-08425

DIRECT DETECTION OF SALMONELLA SPP. IN ESTUARIES BY USING A DNA PROBE.
Center of Marine Biotechnology, Baltimore, MD.
For primary bibliographic entry see Field 5A.
W90-08427

LIMNOLOGICAL CRITERIA FOR THE REHABILITATION OF A COASTAL MARSH. THE ALBUFERA OF MAJORCA, BALEARIC ISLANDS.
Universitat de les Illes Balears, Palma de Mallorca (Spain). Dept. de Biologia y Ciencias de Salud.
A. Martinez-Taberner, G. Moya, G. Ramon, and V. Forteza.
AMBIO AMBOCX, Vol. 19, No. 1, p 21-27, 1989. 9 fig, 37 ref.

Descriptors: *Balearic Islands, *Coastal marshes, *Coastal waters, *Estuaries, *Rehabilitation, *Water pollution control, *Water quality control, *Wetlands, Lagoons, Lentic environment, Limnology, Lotic environment, Majorca, Nitrogen, Phosphates, Salinity.

Many humid coastal areas are ecosystems in regression due to human interference. Due to this fact studies dealing with the management and preservation or rehabilitation of natural zones are es-

sential to balance social and economic development. The Albufera was formed during the Rissian regressions and transgressions and consists of two basins that were filled progressively. During the last century it was an area of diverging watercourses with little potential energy and a highly fractalized structure. At present it is an artificial system where the waters are forced to take the shortest route to the sea and where all the lagoons have been altered in some way. As a result, the Albufera features two distinct aquatic environments, i.e. a lentic system with a reduced number of lagoons, and a lotic system of irrigation and drainage canals. A principal component of the lentic environment is the salinity gradient, as defined by conductivity, chlorides and anions in general. One can summarize the dynamics of the lagoons as follows: productive summers under the influence of the sea, less productive autumns with decreasing salinity, scarcely productive winters with low salinity, and productive springs somewhat under the influence of the sea. Phosphates and the nitrogen-phosphorus ratio are main parameters of the lotic environment. Nutrient inputs into the Albufera have two important sources: leaching from farm soil, and urban effluents. A gradient is established between the above two extremes, i.e. water inputs from rural and urban sources. It is concluded that urban pollution must be eradicated and nitrogen compounds must be monitored as a first step towards the rehabilitation of the Albufera as a conservation area. An aim of rehabilitation would be to prevent waters from following the shortest path to the sea. This could be achieved by progressively reintroducing preexisting lagoons, and distributing them along the gradient. (Agostine-PTT)
W90-08446

CHEMICAL POLLUTION STATUS OF THE NORTH SEA.
Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab.
For primary bibliographic entry see Field 5B.
W90-08455

FISH IN THE POLLUTED NORTH SEA.
Bundesforschungsanstalt fuer Fischerei, Hamburg (Germany, F.R.). Inst. fuer Kuesten- und Binnenfischerei.
For primary bibliographic entry see Field 5C.
W90-08456

FISH REPRODUCTION AND THE IMPACT OF ACIDIFICATION IN THE KYRONJOKI RIVER ESTUARY IN THE BALTIC SEA.
Finnish Game and Fisheries Research Inst., Helsinki.
For primary bibliographic entry see Field 5C.
W90-08458

SIZE SEPARATION OF INTERSTITIAL WATER IN MARINE SEDIMENTS.
Environmental Research Lab.-Duluth, MN.
T. Shiba.
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 55, No. 12, p 2179-2183, December 1989. 6 fig, 19 ref.

Descriptors: *Carbohydrates, *Clays, *Interstitial water, *Marine sediments, *Sand, *Water chemistry, Diffusion, Nutrients.

Interstitial waters of marine sediments from the tidal flats at Utsuchi Bay were separated into two portions: a large interstitial water extracted from sediment core samples by centrifugation at 42 x g for 30 min, and a small interstitial water extracted at 1500 x g from the residual sediment samples. The content of the large interstitial water was high in sandy sediment, while the small interstitial water was in silty and clayey sediment. Concentrations of polymeric carbohydrates were higher in the small interstitial water than in the large interstitial water, although no difference was found in monomeric carbohydrate. It was suggested that monomeric carbohydrates were uniformly distributed in marine sediments by diffusion, while polymeric carbohydrates were not. (Author's abstract)

W90-08464

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

TERMINOLOGY FOR MEMBRANE DISTILLATION.
Technische Univ. Twente, Enschede (Netherlands). Dept. of Chemical Technology.
K. Smolders, and A. C. M. Franken.
Desalination DSLNAH, Vol. 72, No. 3, p 249-262, January 1989. 5 fig, 7 ref, append.

Descriptors: *Desalination, *Distillation, *Membrane processes, Separation techniques.

Terms, definitions and symbols, which are used in the field of membrane distillation were defined by the Workshop on Membrane Distillation held in Rome on May 5, 1986. The name membrane distillation should be applied for membrane operations where the membrane is porous, not wetted by process liquids, has no capillary condensation inside the pores of the membrane, transports only vapors, does not alter the vapor-liquid equilibrium of the different components in the process liquids, has at least one side in direct contact with the process liquid, and has a partial pressure gradient in the vapor phase as the driving force for each component of the membrane. Direct-contact membrane distillation is a system in which the liquid on both sides of the membrane is in direct contact with the membrane and in which the liquid on the downstream side is used as the condensing medium. Gas-gap membrane distillation is a system in which the vapor on the downstream side is condensed against a cooling surface and in which the condensed liquid on the downstream side does not have to be in contact with the membrane. In low pressure membrane distillation a low pressure is applied downstream and the condensation of the permeate takes place outside the module. In sweeping gas membrane distillation a gas such as nitrogen is applied downstream and the condensation of the permeate takes place outside the module. Membranes used in membrane distillation should be characterized by the following membrane performance parameters: polymer material, thickness of the membrane, porosity, nominal pore size, and liquid-entry-pressure of water. As additional information, the following membrane characteristics can be given: IPA bubble point, maximum pore size, pore size distribution, pore size morphology, temperature stability, and chemical resistance. Evaporation efficiency, process efficiency, concentration factor, and temperature polarization coefficient are defined to characterize a membrane distillation operation and a membrane distillation process. Definitions and symbols used in membrane distillation processes are given and the determination of membrane characteristics and the liquid-entry-pressure of water are defined. (Geiger-PTT)
W90-07965

ELECTRICAL CONDUCTIVITY AND TOTAL DISSOLVED SOLIDS: WHAT IS THEIR PRECISE RELATIONSHIP.
Hydrogeochemical Engineer and R.O. Consultant, 25, Eric Lock Road, Shrewsbury SY3 0HQ, England.
N. R. G. Walton.
Desalination DSLNAH, Vol. 72, No. 3, p 275-292, January 1989. 1 fig, 4 tab.

Descriptors: *Conductivity, *Desalination, *Dissolved solids, *Reverse osmosis, *Water chemistry, Brines, Mathematical studies, Salinity, Seawater, Temperature effects.

The relationship between electrical conductivity (EC) and total dissolved solids is affected by temperature and water types according to salinity. Since total dissolved solids are not easily measured except under controlled conditions in reputable laboratories, a practical compromise is suggested

utilizing four different K factors representing one for each water type encountered in the desalination industry. The use of just one K factor for all water types cannot be justified since errors of up to 25% can be introduced from just this one approximation alone. The temperature effect on EC has been shown to be different for each individual ion present, although the use of the standard approximation of 2.2% per 1 C is good enough for most mixed-ion waters within +/-15 C of the 25 C standard reference temperature. The new relationship proposed relates EC to total dissolved solids using a K factor ranging from 0.50 to 0.75 to account for increasingly saline waters. (Geiger-PTT)
W90-07966

MODELING OF CALCIUM SULPHATE FOULING OF REVERSE OSMOSIS MEMBRANES.
National Technical Univ., Athens (Greece). Faculty of Chemical Engineering.
E. Fountoukidis, Z. B. Maroulis, and D. Marinos-Kouris.
Desalination DSLNAH, Vol. 72, No. 3, p 293-318, January 1989. 14 fig, 2 tab, 5 ref.

Descriptors: *Desalination, *Fouling, *Mathematical models, *Reverse osmosis, Calcium sulfate, Membrane processes, Model studies, Permeability.

The phenomenon of calcium sulfate deposits on reverse osmosis membranes was studied theoretically using a laboratory desalination apparatus. A mathematical model was proposed and solved, which predicted the permeate flux, as well as the mass of deposits on the membrane as a function of time. The model is based on the following assumptions: (1) the rate of deposition is proportional to the deviations from equilibrium conditions, and (2) the membrane permeability decrease is proportional to the mass of deposited salt. The ability of the model to describe the phenomenon and the accuracy of its predictions are satisfactory, as shown by the relevant experimental validation. (Author's abstract)
W90-07967

DYNAMICALLY FORMED HYDROUS ZIRCONIUM (IV) OXIDE-POLYELECTROLYTE MEMBRANES: V. NON-HOMOGENEOUS POLY(ACRYLIC ACID-COVINYL ALCOHOL) MEMBRANES: REJECTION AND FLUX PROPERTIES AND THE TREATMENT OF COAL GASIFICATION WASTE WATER.
Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
For primary bibliographic entry see Field 5D.
W90-07968

ELECTRODIALYSIS-CONTACT SLUDGE REACTOR AND REVERSE OSMOSIS-PHASE SEPARATOR, TWO EXAMPLES OF A SIMPLE PROCESS COMBINATION FOR INCREASING THE WATER RECOVERY RATE OF MEMBRANE PROCESSES.
Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl fuer Verfahrenstechnik 1 und Inst. fuer Verfahrenstechnik.
R. Rautenbach, W. Kopp, and C. Herion.
Desalination DSLNAH, Vol. 72, No. 3, p 339-349, January 1989. 9 fig, 2 tab, 7 ref.

Descriptors: *Desalination, *Electrodialysis, *Evaporation, *Membrane processes, *Reverse osmosis, Adsorption, Clarification, Distillation, Separation techniques, Sludge.

In two case studies, the limits of membrane processes with respect to retentate concentration or water recovery rate have been substantially extended by adding a relatively simple low-cost mechanical unit operation. In the first case a crystalizer-clarifier is integrated into the retentate loop of an electrodialysis unit. In connection with the seeding technique, scaling or blocking of the electrodialysis membranes and spacers can be avoided even at very high water recovery rates and, therefore, high salt concentrations in the retentate loop can be achieved. In the second case, a gravity settler (phase separator) is integrated into the re-

tentate loop of a reverse osmosis unit separating water from an aqueous solution of several organic solvents. Very often these solvents are partially immiscible with water. In cases where a concentration by reverse osmosis up to the region of partial immiscibility is possible, an organic phase can be withdrawn from the phase separator. The aqueous phase of the phase separator is recycled to the reverse osmosis unit. By this simple combination, water recovery rates are obtained that substantially exceed the limits of reverse osmosis set by osmotic pressure and chemical stability of the membranes. (Geiger-PTT)
W90-07969

PITTING CORROSION BEHAVIOUR OF ALUMINIUM IN WATER DESALINATION PLANTS.
National Research Centre, Cairo (Egypt). Dept. of Electrochemistry.
M. G. A. Khedr, M. M. H. Badran, and A. A. El Azhari.
Desalination DSLNAH, Vol. 72, No. 3, p 351-366, January 1989. 10 fig, 32 ref.

Descriptors: *Aluminum, *Corrosion, *Corrosion control, *Desalination, Cadmium, Copper, Pipes.

The pitting corrosion of aluminum in water containing pitting corrosion agents and metal cations at moderately high temperatures has been investigated by electrochemical and surface analysis methods. Heat pretreatment ameliorated the resistance to pitting corrosion and overcame the aggressive effect of Cl(-). This is attributed to the thickening of the protective film and change of its composition into more stable oxides as shown by Auger depth profiling and X-ray diffraction, respectively. Such modifications would shield the points susceptible to pitting initiation and/or suppress the kinetics of the partial cathodic reaction. The severe pitting corrosion suffered by aluminum in the presence of Cu(++) decreased by heat treatment. The induced film modification hinders the deposition of metallic copper by displacement on aluminum surface and, therefore, inhibits the galvanic coupling. In Cd(++) solutions, where the mixed oxide CdO-6Al2O3 was detected on aluminum surface, film modification was not obtained. (Author's abstract)
W90-07970

TECHNICAL AND ECONOMICAL COMPARISON BETWEEN LARGE CAPACITY MULTI STAGE FLASH AND REVERSE OSMOSIS DESALTING PLANTS.
Kuwait Univ., Safat. Dept. of Mechanical Engineering.
M. A. Darwish, M. Abdel-Jawad, and G. S. Aly.
Desalination DSLNAH, Vol. 72, No. 3, p 367-379, January 1989. 4 fig, 4 tab, 11 ref.

Descriptors: *Desalination, *Multistage flash distillation, *Reverse osmosis, Comparison studies, Economic aspects, Energy costs, Membrane processes, Operating costs.

In the course of evaluating the unit cost of desalted water by either the predominant multistage flash (MSF) distillation, and its competitor reverse osmosis (RO) desalting systems, a quantitative comparison of the equipment used was conducted. The chemical and energy consumptions were also compared for both systems. More expensive materials and more energy were consumed in the MSF system than in RO so that the unit cost of seawater desalted by the RO system was lower than that obtained by the MSF system. Moreover, prospects for lower cost by the RO system exist by developing a more efficient energy recovery system and reducing the cost of the membranes. It is believed that the present cost of membranes is much higher than the real manufacturing cost. (Author's abstract)
W90-07971

TECHNICAL ASPECTS OF REDUCING DESALTING WATER COSTS IN DISTILLATION METHODS.
Kuwait Univ., Safat. Dept. of Mechanical Engi-

neering.
M. A. Darwish, and M. Abdel-Jawad.
Desalination DSLNAH, Vol. 72, No. 3, p 381-393, January 1989. 7 fig, 2 tab, 4 ref.

Descriptors: *Capital costs, *Desalination, *Multistage flash distillation, *Operating costs, Case studies, Comparison studies, Energy costs, Kuwait, Water costs.

Reducing the cost of desalted water is of great significance in countries such as Kuwait that depend mainly on desalted water to satisfy their potable water needs. The unit costs of desalted water produced by multistage flash distillation (MSF) plants can be reduced by increasing the MSF unit capacity, changing the polyphosphate pretreatment to a high temperature additives pretreatment method, and discontinuing the use of small MSF units that are operated directly by boilers. MSF units with installed capacity of twice the real needs of the community increases (about doubles) the capital share of desalted water costs. The multi-effect horizontal tube evaporator distillation desalting (ME) system is more efficient, from a thermodynamic and heat transfer point of view than the predominant MSF desalination system. When both the MSF system and the ME system are supplied with steam after its expansion in steam turbines, the ME system produced desalted water at a lower cost (about 50%) than the MSF system. Since the ME system operates with top brine in the temperature range of 60 C, the potential of scale formation, corrosion, and the cost of pretreatment is reduced. Mechanical or thermal vapor compression desalting systems are more cost effective when compared with direct boiler operated MSF systems. (Geiger-PTT)
W90-07972

PROSPECTS OF HYBRID RO-MSF DESALTING PLANTS IN KUWAIT.
Kuwait Univ., Safat. Dept. of Mechanical Engineering.
A. M. R. Al-Marafie.
Desalination DSLNAH, Vol. 72, No. 3, p 305-404, January 1989. 4 fig, 10 tab, 9 ref.

Descriptors: *Desalination, *Kuwait, *Multistage flash distillation, *Reverse osmosis, Consumptive use, Energy costs, Membrane processes, Operating costs, Water requirements.

A hybrid single-stage reverse osmosis-multistage flash (RO-MSF) desalting plant is more economically feasible to handle Kuwait's increased potable water demands than the conventional MSF desalting plants. The suggested hybrid system consists of a single-stage RO desalting unit coupled to an MSF plant. The MSF plant is linked with a steam power plant thus forming a cogeneration plant. The distilled product from MSF is blended with RO product having a salt content of 1000 ppm. This gives potable water if both MSF and RO plants have the same capacity. Energy consumption is reduced from 17.06 kilowatt-hr to 11.53 kilowatt-hr using the hybrid system. Part of the MSF heat rejection stream, at relatively high temperature, is used as a feed water to the reverse osmosis unit. Such an arrangement would increase RO plant production in low temperature seasons. The need of brackish water to bring up the salt content of MSF distilled water to WHO standard is eliminated. Hence, the limited brackish water resources are saved from rapid exhaustion. A single seawater intake is used to supply feed water to RO as well as MSF plants, avoiding extra costs of double intakes. Electrical energy to run RO is taken directly from the powerplant, thus avoiding the transmission loss and costs. (Geiger-PTT)
W90-07973

PERFORMANCE OF THE SOLAR DESALINATION PLANT AT ABU DHABI.
Water and Electricity Dept., Abu Dhabi (United Arab Emirates).
A. M. El-Nashar.
Desalination DSLNAH, Vol. 72, No. 3, p 405-424, January 1989. 18 fig, 4 tab, 5 ref.

Descriptors: *Desalination, *Evaporators, *Solar energy, Evaporation, Performance evaluation, United Arab Emirates.

The solar desalination plant built on the Umm Al Nar Power and Desalination complex located near Abu Dhabi consists of three systems: a solar energy collection system, a hot water storage system (heat accumulator), and a sea water evaporator. The water storage system (heat accumulator) consists of three vertical cylindrical vessels with a total capacity of 300 cu m, connected in series by large diameter piping and thermally stratified so that mixing of the hot and cold water is minimized. The solar energy collection system consists of 1064 evacuated tube collector panels arranged in 76 rows of 14 panels each connected in series. The heat accumulator system acts as the heat storage device which stores the excess heat collected during the day for use by the evaporator during the night. The system consists of three vertical cylindrical tanks having a total capacity of 300 cu m and contains hot water at a temperature normally ranging between 50 and 90 C. The multi-effect-stack evaporator has 18 effects and a condenser vertically stacked in a two-tier arrangement. The plant operates in a fully automatic fashion. During the first year of operation, the monthly average collection efficiency of the solar desalination plant varied from about 53% during the summer months to 46% during the winter months with a yearly average of about 50%. The performance ratio of the evaporator was maintained above 13.0 during most of the time in which the evaporator was in continuous operation. The heat consumption by the evaporator accounted for 37.1% of the incoming radiation during winter months but increased to 47.4% during summer months. (Geiger-PTT)
W90-07974

CONVENTIONAL PRETREATMENT OF SURFACE SEAWATER FOR REVERSE OSMOSIS APPLICATION, STATE OF THE ART.
Kuwait Inst. for Scientific Research, Safat. Water Desalination Dept.
A. Y. Al-Borno, and M. Abdel-Jawad.
Desalination DSLNAH, Vol. 74, No. 1/3, p 3-36, November 1989. 3 tab, 42 ref.

Descriptors: *Desalination, *Pretreatment of water, *Reverse osmosis, Bahrain, British West Indies, Fouling, Japan, Kuwait, Malta, Performance evaluation, Process control, Puerto Rico, Saudi Arabia, Scaling, Seawater, Suspended solids, Water treatment.

Conventional methods have been used to pretreat surface seawater prior to desalination by reverse osmosis (RO) membrane technology. The successful treatment should remove most fouling-promotion compounds, scale products, and suspended materials. The extent of seawater treatment is site-dependent. The various technologies, capacities, efficiencies, and problems are reviewed of the various treatment systems currently used to treat surface seawater for RO application and potential improvements in process steps and chemical consumption are discussed. The conventional seawater pretreatment process prior to RO usually includes such stages as disinfection, coagulation and flocculation, sedimentation and filtration, dechlorination, and scale control. The performance of the pretreatment systems was examined at certain RO plants: Doha RO Plant, Kuwait; Ra's Abu Jarjour RO Plant, Bahrain; Al-Birk RO Plant, Saudi Arabia; Umm Lujj RO Plant, Saudi Arabia; Jedda RO Plant, Saudi Arabia; Ra's Al-Khfji RO Plant, Saudi Arabia; Culebra RO Plant, Puerto Rico; Grand Cayman RO Plant, British West Indies; Chigasaki RO Plant, Japan; and Ghar Lapsi RO Plant, Malta. The extent of pretreatment clearly affects performance of RO membranes. Conventional pretreatment is very effective for making surface seawater ready for RO during most of the year. Most problems were associated with inadequate disinfection of the feed and a high degree of elimination of foulants. (Rochester-PTT)
W90-08038

PERFORMANCE EVALUATION OF SWCC SWRO PLANTS.

Saline Water Conversion Corp., Al-Jubail (Saudi Arabia). Research, Development and Training Center.
A. M. Hassan, S. Al-Jarrah, T. Al-Lohibi, A. Al-Hamdan, and L. M. Bakheet.
Desalination DSLNAH, Vol. 74, No. 1/3, p 37-50, November 1989. 4 tab, 11 ref.

Descriptors: *Desalination, *Membrane processes, *Reverse osmosis, *Saudi Arabia, Disinfection, Fouling, Performance evaluation, Saline water, Water treatment.

Performance of three Saline Water Conversion Corporation (SWCC) seawater reverse osmosis (SWRO) plants was evaluated. The plants were: Umm Lujj, commissioned July 1986, 4400 cu m/day; Al-Birk, commissioned December 1983, 2275 cu m/day; and Jeddah, commissioned 1979, 12,000 cu m/day. No membrane replacement took place in any of the three plants. Despite this, the three plants showed only modest declines annually in their productivity, (2.5% at Jeddah, 3.5% at Umm Lujj, and 7.17% at Al-Birk). The larger decline at Al-Birk possibly was due to biofouling of the membrane. Product water quality (less than 250 ppm total dissolved solids (TDS)) at Umm Lujj and Al-Birk was within World Health Organization limits. The decline in salt rejection at both plants was less than 0.2% per year. Salt rejection has declined at the Jeddah plant, indicating structural damage to the membrane. Both Umm Lujj and Jeddah had high plant availability (over 95%), but their water recovery was modest (24-28%). Biological fouling was a problem at the Al-Birk plant, where feed was chlorinated (4 ppm) and dechlorinated. No biofouling was reported at the other two plants, where the feed was disinfected by CuSO4 (0.5-1 ppm). Other problems encountered were material corrosion, especially SS 316 and SS 316L in both treatment and desalination parts at Jeddah. (Author's abstract)
W90-08039

NEW CHLORAMINE PROCESS TO CONTROL AFTERGROWTH AND BIOFOULING IN PERMASEP B-10 RO SURFACE SEAWATER PLANTS.
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
L. E. Applegate, C. W. Erkenbrecher, and H. Winters.
Desalination DSLNAH, Vol. 74, No. 1/3, p 51-67, November 1989. 14 tab, 13 ref.

Descriptors: *Chlorination, *Desalination, *Reverse osmosis, Bacteria, Chloramine, Fouling, Humic acids, Membrane processes, Permasep B-10, Permeators, Saline water, Seawater, Temperature, Water treatment.

Surface seawater reverse osmosis (RO) plants using Permasep B-10 permeators typically use chlorination-dechlorination in the pretreatment system to control biological activity. For such plants, bacterial aftergrowth and biofouling in the B-10 permeators can occur when the water temperature rises above 25 C. The bacterial aftergrowth can be significant, requiring frequent disinfection and cleaning of the permeators, which reduces the efficiency of the RO plant. Using bacteria isolated from Middle East B-10 RO plants, aftergrowth in a model seawater system was studied extensively over a pH range of 6-8 and a temperature range of 15 C to 35 C. Both planktonic (growth in solution) and periphytic (growth on surfaces) studies showed clearly that the degradation of humic acid (as well as other organics) by chlorine accelerated aftergrowth. The bacterial aftergrowth was influenced by pH and temperature and was directly proportional to the availability of assimilable organic compounds. Chlorine degradation of humic acid in seawater produced these assimilable organic compounds that led to bacterial aftergrowth and biofouling. The degree of humic acid degradation by chlorine was dependent on pH, temperature, and the concentration of chlorine. Chloramine, a disinfectant which was generated in situ, was extensively examined as an alternative to chlorine. Chloramine was a better disinfectant and did not degrade humic acid. In addition, significantly less aftergrowth was observed in

the chloramine process (chloramine followed by neutralization with sodium bisulfite). B-10 permeators were found to be completely compatible with the chloramine process. Even brief exposure of B-10 permeators to chloramine did not significantly affect the RO performance. The chloramine process is a significant discovery that should control biofouling in seawater RO plants. (Author's abstract)
W90-08040

BIOLOGICAL FOULING AND CONTROL AT RAS ABU JARJUR RO PLANT: A NEW APPROACH.
Ministry of Public Works, Power and Water, Manama (Bahrain). Water Supply Directorate.
S. R. Ahmed, M. S. Alansari, and T. Kannari.
Desalination DSLNAH, Vol. 74, No. 1/3, p 69-84, November 1989. 6 fig, 2 tab, 3 ref.

Descriptors: *Bahrain, *Brackish water, *Desalination, *Fouling, *Reverse osmosis, Groundwater, Hydrogen ion concentration, Membrane processes, Performance evaluation, Ras Abu Jarjur, Saline water, Temperature, Water treatment.

The Ras Abu (Bahrain) reverse osmosis (RO), which uses deep groundwater containing H2S, has been in operation for the past 4 yr, without any serious problems. However, biofouling of the membranes has been building up gradually and appeared to start affecting the performance after 2 yr of operation. Several investigations have been carried out to resolve this problem. Sodium hexametaphosphate (SHMP) tanks were the major source of biological interaction and the results of the total bacterial count (TBC: colonies/ml) were too numerous to count within 2-3 days of make-up. SHMP is a polyphosphate the reversion of which into orthophosphate is affected by factors of concentration, temperature, time, and pH. Due to the presence of H2S in the feed water, usage of chlorine is avoided even in the trace levels. Sodium metabisulfite (SBS) was considered for sterilization of SHMP tanks and dosing lines. Experiments and trials in the plant showed positive results, such as improved Micron Guard Filter and RO membrane performance by preventing aerobic bacteria contamination entering the feed water from the SHMP tanks and dosing line. Optimum concentration of SBS to be added to the SHMP tanks was 0.25%, which controlled bacteria and did not affect SHMP reversion to orthophosphate. Paint peeling from pipes had a negative effect on performance by allowing light to enter, encouraging photosynthesis. (Rochester-PTT)
W90-08041

PERFORMANCE OF MATERIALS USED IN SEAWATER REVERSE OSMOSIS PLANTS.
Kuwait Inst. for Scientific Research, Safat.
J. Carew, J. Abdel-Jawad, A. Julka, and Y. Al-Wazzan.
Desalination DSLNAH, Vol. 74, No. 1/3, p 85-112, November 1989. 12 fig, 8 tab, 17 ref.

Descriptors: *Desalination, *Desalination plants, *Materials testing, *Reverse osmosis, Corrosion, Doha Reverse Osmosis Plant, Economic aspects, Fouling, Kuwait, Membrane processes, Performance evaluation, Saline water, Scaling, Steel, Water treatment.

Doha Reverse Osmosis Plant (DROP) has been in operation for more than 4 yr. The plant consists of three different reverse osmosis (RO) membrane configuration systems, each of which has its own materials requirements. Materials used for piping, pumps, valves, and control systems were surveyed critically. A testing program was initiated to generate data that will provide a sounder basis by which these materials may be selected for use in RO plants. A number of alloys were selected for the study to evaluate their behavior in the various environments encountered in the reverse osmosis desalination plant. Corrosion performances and material behavior were evaluated in terms of weight loss in the plant. Pitting and crevice susceptibility were assessed in the plant as well as by electrochemical studies in the laboratory. A once-

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through pilot plant that could simulate most of the water conditions encountered in the reverse osmosis plant was constructed. Coupon weight losses of selected alloys are being determined under variables of pH, temperature, and flow velocity. Preliminary work is still in progress. Results obtained from the program so far appear to favor the use of high alloyed stainless steels in many areas of RO plants. The economic incentive for extensive use of steel will depend on the results of long-term studies currently on the way. (Author's abstract)
W90-08042

IMPROVING REVERSE OSMOSIS PERFORMANCE THROUGH PERIODIC CLEANING.
Pfizer, Inc., New York.
S. I. Graham, R. L. Reitz, and C. E. Hickman.
Desalination DSLNAH, Vol. 74, No. 1/3, p 113-124, November 1989. 9 fig.

Descriptors: *Desalination apparatus, *Fouling, *Maintenance, *Reverse osmosis, California, Cleaning, Florida, Pressure, Saline water, Salinity, Temperature, Water treatment.

Periodic cleaning of a membrane to remove foulant accumulations is essential to maintain quality and quantity of product water and maximize membrane life in reverse osmosis (RO) plants. Issues of when to clean, how to select a chemical treatment, and how to evaluate the process of the cleaning procedure are discussed. Operating histories of RO systems are discussed, as follows: a mobile home park (Florida), a utility (Florida), a power generating station (Southern California), and a nuclear power plant. Periodic cleaning is an essential procedure in any RO plant experiencing fouling. The decision criteria for instituting a cleaning procedure should be based on loss of plant performance relative to a set of standard conditions. This requires normalization of operating data to account for changes in salinity, temperature, and pressure. Because and RO membrane is in risk of permanent damage if fouling is allowed to progress beyond reasonable limits, normalization procedures should be incorporated into an operator's daily routine. In the examples cited here, the FLOCLEAN line of cleaning chemicals was used to rejuvenate systems after performance had deteriorated well beyond the recommended point for cleaning procedures. (Rochester-PTT)
W90-08043

STANDARDIZATION OF PERFORMANCE DATA FOR REVERSE OSMOSIS DESALINATION PLANTS.
Kuwait Inst. for Scientific Research, Safat.
B. A. Q. Darwish, A. Abdel-Jawad, and G. S. Aly.
Desalination DSLNAH, Vol. 74, No. 1/3, p 125-140, November 1989. 12 fig, 3 ref. Kuwait Foundation for the Advancement of Science Grant KFAS 86-06-01.

Descriptors: *Desalination, *Performance evaluation, *Reverse osmosis, Comparison studies, Doha Reverse Osmosis Plant, Kuwait, Membrane processes, Saline water, Standards, Water treatment.

Comprehensive operating data generated over a period of more than 3 yr by Doha Reverse Osmosis Plant (Kuwait) was used to compare the accuracy of two methods of standardizing reverse osmosis (RO) performance data. The American Society for Testing and Materials (ASTM) method, applied for both spiral wound and hollow fiber membrane systems, and the UOP method, applied to spiral wound membrane systems. The UOP method resulted in better standardization of both permeate flow rate and salt rejection for both stages of the spiral wound membrane configuration. For a plant operation time of 36 months, the average difference between both methods was 1.2% and 5.8% for the salt rejection first and second stages, respectively, and 8.0% and 4.6% for the permeate flow rate of first and second stages, respectively. The UOP method needs, however, more detailed input data compared to the ASTM method. An attempt was made to modify the UOP method by application with the hollow fiber membrane system configuration. A smaller difference range of salt rejection was obtained, ranging between 0.8% for the first stage and 2.0% for the second stage.

On the other hand, the average difference between the two methods was 15.3% and 9.4% for the permeate flow rate leaving the first and second stages, respectively. The standardized performance data using the UOP method were closer to the design data. (Author's abstract)
W90-08044

SCALING POTENTIAL OF KUWAIT SEAWATER FOR REVERSE OSMOSIS DESALINATION.
Kuwait Inst. for Scientific Research, Safat. Water Desalination Dept.
S. E. Ebrahim, and B. A. Darwish.
Desalination DSLNAH, Vol. 74, No. 1/3, p 141-156, November 1989. 9 tab, 11 ref. Kuwait Foundation for the Advancement of Science Grant KFAS 86-06-01.

Descriptors: *Desalination, *Kuwait, *Reverse osmosis, *Scaling, Doha Reverse Osmosis Plant, Hydrogen ion concentration, Membrane processes, Seawater, Sodium hexamate phosphate, Sulfuric acid, Temperature.

Sulfuric acid is used at the Doha Reverse Osmosis Plant (DROP) in Kuwait for three purposes: (1) to adjust the pH of untreated seawater entering a coagulation-flocculation system for enhancing the coagulation process, (2) to adjust the pH of the feed to the reverse osmosis (RO) systems for maximum salt rejection and (3) to minimize the carbonate scaling potential of the feed to the RO systems. Sodium hexamate phosphate (SHMP) is added as a precaution against the formation of sulfate scaling (ie, calcium, barium, strontium). During four years of operation, DROP consumed considerable quantities of acid and SHMP, which affected the unit cost of produced water. The Stiff and Davis stability index, solubility product, and ion product were calculated for the brine at different feed total dissolved solids (TDS). The limits for carbonate and sulfate scaling at different TDS and recoveries are established for Kuwait seawater. Freshwater pH of 7.1 and 30% recovery can be used without danger of membrane scaling. At this feedwater pH and recovery, antiscalant is not necessary. Recovery can be increased depending on feedwater temperature and the addition of antiscalant. Acceptable SDI values can be achieved by the common pretreatment system, using feedwater with pH 7.1. Excellent salt rejection can be obtained at a feedwater pH of 7.1. A 49.7% saving in acid consumption can be achieved if pH 7.1 is used rather than pH 6.0 for the feedwater to the common pretreatment. At feedwater pH 7.1, and without the addition of antiscalant, the savings in chemical cost per cubic meter of produced water ranged from 26.9-60.7%. (Rochester-PTT)
W90-08045

CORROSION RESISTANT MATERIALS FOR SEAWATER RO PLANTS.
Saline Water Conversion Corp., Al-Jubail (Saudi Arabia). Research, Development and Training Center.
A. M. Hassan, and A. U. Malik.
Desalination DSLNAH, Vol. 74, No. 1/3, p 157-170, November 1989. 2 tab, 14 ref.

Descriptors: *Corrosion, *Desalination, *Desalination plants, *Materials testing, *Reverse osmosis, *Saudi Arabia, Alloys, Design criteria, Membrane processes, Oxygen, Performance evaluation, Saline water, Seawater, Steel, Surveys.

A survey of corrosion-resistant materials employed in Seawater Reverse Osmosis (SWRO) desalination plant in Saudi Arabia and the GCC countries has been carried out with special reference to stainless steels. The history of the application of these materials is reviewed along with the major corrosion problems encountered in those plants with main emphasis on Saline Water Conversion Corporation (SWCC) reverse osmosis (RO) desalination plants. The two stainless steel (SS) alloys 316L and 317L have been used in the construction of the two SWCC SWRO plants at the remote area plants of Al-Birk Umm Lujj with noticeable corrosion damage in either plant after their operation for over 5 yr and 3 yr, respectively. Similarly, other

SS alloys 317LN, 904L, 254SMO, and 329 performed well, without any significant corrosion when they were used in the construction of SWRO plants or parts thereof in the GCC countries. These plants have been in continuous operation for years. Numerous SS alloys (316L, 317L, 317LN, 904L, 254SMO, and 329) performed well against corrosion. With good plant design and good operational and maintenance procedures, it should be safe to use any of those alloys in the construction of SWRO plants even at high TDS in seawater (43,000 ppm). Oxygen is of key importance in corrosion of desalination plants equipment in general and multistage flash in particular. Good corrosion performance has been noted with deaerated feed. (Rochester-PTT)
W90-08046

TWENTY YEAR CASE HISTORY: B-9 HOLLOW FIBER PERMEATOR.
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
I. Moch.
Desalination DSLNAH, Vol. 74, No. 1/3, p 171-181, November 1989. 6 fig, 2 tab, 10 ref.

Descriptors: *Desalination, *Membrane processes, *Reverse osmosis, Brackish water, Fouling, History, Performance evaluation, Permeators.

Twenty years ago, Du Pont introduced its proprietary, brackish water, hollow fiber, aramid B-9 permeator. The introduction of this product made reverse osmosis (RO) an economically viable technology. Over 100,000 permeators, processing over 3 million cubic meters of water per day, have been supplied to all areas of the world for use in potable, commercial, and industrial applications. The chemistry and engineering of this desalination device are reviewed, significant long-lived applications are described, and future perspectives are presented. Several improvements have been made in the device over the last 20 years, including increasing flow per module by 28% to 16,000 gpd for an 8-inch module, decrease in salt passage from 10% to 5% absolute, and the flux in the module has been optimized at 3-5 gallons/square foot of membrane per day. The fouling characteristics have been defined rigorously been defined at SDI 3 or less, so that water quality and quantity can be guaranteed. Customers report the following benefits using the product in brackish water: demonstrated low membrane replacement rates, long-term storage life, stable flow and salt passage, minimal space requirements and ease of handling, and no biological degradation. Future improvements can be expected in the areas of improved salt rejection, higher flow modules, higher permissible fouling indices, more efficient modules, and long-life modules providing lower replacement rates. (Rochester-PTT)
W90-08047

THREE-YEAR EXPERIENCE OF A SEAWATER RO PLANT OPERATING AT A CONVERSION GREATER THAN 50% IN THE CAYMAN ISLANDS.
Fairleigh Dickinson Univ., Teaneck, NJ.
H. Winters.
Desalination DSLNAH, Vol. 74, No. 1/3, p 183-185, November 1989. 2 ref.

Descriptors: *Cayman Islands, *Desalination, *Membrane processes, *Reverse osmosis, Fouling, Performance evaluation, Permasep B-10T, Permeators, Saline water, Seawater, Water treatment.

A seawater RO plant using Permasep B-10T permeators has been in operation for 24,000 hr in the Cayman Islands at a conversion greater than 50%. This plant produces 600 cu m/day with a product quality of less than 305 mg/l. The RO skids were designed to operate at high pressure (maximum 1200 psig) using 1:1 brine staging of the permeators. The pretreatment consist only of 5-micron cartridge filtration despite the presence of dissolve organics (20 mg/l) and bacteria (1,000/ml). The first-stage permeators exceeded by 3.2%, while the second-stage permeators produced 1.5% less water the projected. The overall productivity has exceeded design projections by 2.7%. The B-10T

hollow fiber membranes have never been cleaned in the 3 yr of operation and have maintained their excellent performance in spite of the high fouling potential of organics and bacteria in the feed water. (Author's abstract)
W90-08048

ECONOMIC AND TECHNICAL FACTORS AFFECTING SEAWATER REVERSE OSMOSIS PROCESS DESIGN.
Allied-Signal, Inc., San Diego, CA. UOP Fluid Systems.
T. E. Sulpizio, W. G. Light, and J. L. Perlman.
Desalination DSLNAH, Vol. 74, No. 1/3, p 187-201, November 1989. 5 fig, 2 tab, 8 ref.

Descriptors: *Desalination, *Reverse osmosis, Design criteria, Economic aspects, Membrane processes, Optimization, Saline water, Seawater, Spreadsheet techniques, Water treatment.

Design of a seawater reverse osmosis (RO) desalination plant requires an economic and technical evaluation of single-stage and two-stage system configurations. Feedwater salinity is an important factor for selecting a particular plant design. The preferred RO design should be derived from an assessment of capital and operating costs. Performance characteristics of commercially available spiral-wound membrane elements were used to prepare the various single-stage and two-stage designs. Spreadsheet techniques were used to make economic evaluations of the designs and to determine equivalent annual costs. In assessing equivalent annual costs, a single-stage design would be preferred for seawater salinities less than 39 g/L and two-stage design would be preferred for seawater salinities greater than 42 g/L. The single-stage design has the advantage of being both simpler in configuration and operation. A two-stage configuration has the technical advantage of being more flexible to adjust for changes in feed salinity or in element performance. (Author's abstract)
W90-08049

TRIHALOMETHANES (THMS) FORMATION IN MULTI-STAGE FLASH (MSF) DISTILLATION PLANTS.
Kuwait Water Resources Development Centre, Safat.
N. A. Latif, F. M. Al-Awadi, and B. A. Colenutt.
Desalination DSLNAH, Vol. 74, No. 1/3, p 205-226, November 1989. 10 fig, 14 ref.

Descriptors: *Desalination, *Reverse osmosis, *Trihalomethanes, *Water pollution sources, *Water treatment, Bromoform, Chlorination, Chlorine, Flash distillation, Fouling, Kuwait, Membrane processes, Organic compounds, Saline water, Seawater.

The presence of trihalomethanes (THMs) in distillate product by multi-stage flash (MSF) distillation plant (Doha East Power Generation and Water Production Station, Kuwait) was monitored. Four THMs were considered: chloroform, bromodichloromethane, dibromochloromethane, and bromoform. The major source of THM formation within the distillation plant is the organic compounds present in the seawater used as make-up feed. The level of THM compounds depends greatly on the method of chlorination and the applied dosage, but both temperature and total organic carbon also are factors. The amount of residual chlorine is the most significant input. Addition of anti-scalant and anti-foam organic compounds also influences the THMs in the make-up stream. The MSF distillation process is very effective in stripping THM compounds from the flashing brine. This is because most of the THMs in the flashing brine move upward into the vapor space of the flash chambers in gaseous form. A substantial amount is then rejected with the vent gases, whereas the rest is condensed along with distillate product. On average only 11.24% of THMs present in the make-up stream end up in the distillate product. The predominant THM compound in all streams covered, apart from the brine blow-down stream, is bromoform. It is thought that this is due to the high level of bromide ions in the seawater used by the plant. (Rochester-PTT)

W90-08050

PREDICTIVE MODEL TO FIND THE OPTIMUM CHLORINE TREATMENT SCENARIO FOR BIOFOULING CONTROL.
Kuwaiti Tech Consultance, Faiha.
For primary bibliographic entry see Field 5F.
W90-08051

MONITORING OF ORGANIC COMPOUNDS IN FEED AND PRODUCT WATER SAMPLES FROM MSF PLANTS IN THE EASTERN COAST OF SAUDI ARABIA.
Saline Water Conversion Corp., Al-Jubail (Saudi Arabia). Research, Development and Training Center.
R. Mayankutty, A. Amin Nomani, and T. S. Thankachan.
Desalination DSLNAH, Vol. 74, No. 1/3, p 243-257, November 1989. 3 fig, 6 tab, 12 ref.

Descriptors: *Desalination, *Flash distillation, *Monitoring, *Saudi Arabia, *Water quality control, *Water treatment, Chemical analysis, Drinking water, Hazardous materials, Organic compounds, Performance evaluation, Public health.

A year-long monitoring of seawater feed, product distillate, and potable water samples from the Al-Jubail multi-stage flash (MSF) plant in eastern Saudi Arabia was conducted to detect the possible presence of toxic organic compounds. Similar studies were done at Al-Khobar and Al-Khafji plants for shorter periods (3-5 mo). Several samples of seawater and product water before and after chlorination and potable water were periodically collected and analyzed for volatile and nonvolatile organic compounds using gas chromatography and gas chromatography/mass spectrometry (GC/MS). Standard chemical analysis techniques were used to quantitative estimate several of the organics and others were qualitatively identified by GC/MS using a computerized library search utility. High concentrations of several organics were detected in hypochlorite samples produced by seawater electrolysis, but most of them were below detection levels in chlorinated seawater used as make-up in the desalination plants. Almost all the organics detected in make-up water were rejected during distillation. Thus, the present studies confirm that MSF is a very efficient process for removing organic contaminants that may be present in seawater. A single phenol compound carried over from the seawater feed to the distillate, in minute concentrations. Two phthalate esters were detected frequently in product and potable water supplies. Their concentrations were too low to cause a toxic effect if present in drinking water. The source of these compounds is suspected to have been plastics used in construction. Traces of trihalomethanes, especially bromo derivatives of methane, were found in all samples of water treated with chlorine. (Rochester-PTT)
W90-08052

FACTORS AFFECTING THE CORROSION BEHAVIOUR OF CN 108 ALLOY IN SEA WATER.
Rome-2 Univ. (Italy). Dept. of Chemical Science and Technology.
G. Gusmano, C. Simoncelli, N. M. Valota, and E. Traversa.
Desalination DSLNAH, Vol. 74, No. 1/3, p 259-276, November 1989. 12 fig, 6 tab, 10 ref.

Descriptors: *Alloys, *Corrosion, *Desalination plants, *Materials testing, *Steel, Chemical reactions, Ions, Iron, Manganese, Performance evaluation, Seawater.

The corrosion performance of 66-30-2-2 and 70/30 Cupro-nickels in seawater is influenced both by surface conditions and operating parameters. Corrosion tests performed in flowing seawater showed good correlation between the corrosion potentials of these alloys and their corrosion performance. The growth of cathodic oxide films always is a cause of initiation of localized corrosion. The trend of the corrosion potential during the first few days of exposure is of paramount importance. If the corrosion potential remains at low levels, the CN

108 alloy will suffer neither pitting nor underdeposit attack. This correlation is consistent with previous results obtained with CN 108. There seemed to be no direct cause-effect relationship between the presence of thermal oxide on the alloy surface and pitting attack. FeSO4 treatment did not seem to be as important as corrosion potential in determine which samples were attacked. the present results suggested a hypothesis that it is the presence of both ferrous/ferric and manganous/manganic ions that is important in corrosion behavior. The hypothesis predicts good corrosion performance when both ferrous and/or manganous ions are present at a concentration sufficient to guarantee the maintenance of low corrosion potential. (Rochester-PTT)
W90-08053

KUWAIT UNIVERSITY PILOT PLANT: A SINGLE MULTI-EFFECT PLANT TO STUDY THE VARIATION OF EVAPORATION PARAMETERS AT DIFFERENT TEMPERATURES.
Kuwait Univ., Safat.
M. A. Darwish, N. M. Al-Najem, T. Fremont, and J. de Gunzborg.
Desalination DSLNAH, Vol. 74, No. 1/3, p 277-288, November 1989. 5 fig.

Descriptors: *Desalination plants, *Evaporation, *Flash distillation, *Kuwait, Design criteria, Performance evaluation, Pilot plants, Saline water.

The Mechanical Engineering Department of Kuwait University has purchased from ENTROPIE, S.A. (France) a specially designed multiple-effect, vertically stacked desalination pilot plant with a capacity of 50 cu m/day. The unit is designed to operate in multi-effect mode at any top brine temperature between 60 C and 110 C. The unit also can be run with specially designed thermocompressors at 60 C and 110 C. The plant consists of the following components: (1) a multi-effect evaporator with three vertically stacked cells with horizontal tube bundles; (2) four horizontal tube preheaters to preheat feed water before spraying it on tubes of the first effect by means of perforated plates; (3) two heat rejection sections, including two condensers and one flashing chamber where the fresh water produced is cooled down; (4) a pressure reducing/desuperheating system; (5) a set of vacuum ejectors with silencer to remove the non-condensible gases and keep the unit under vacuum; (6) two thermocompressors; (7) a chemical injection system for treating feed water; and (8) a full set of instrumentation and control components. A similar unit employed at a solar plant can operate in multi-effect mode at 35% to 120% of nominal capacity without altering significantly the gain output ratio. (Rochester-PTT)
W90-08054

NOVEL 2500 GPD 5-EFFECTS WIPED-FILM ROTATING-DISK VAPOR-COMPRESSION MODULE: PRELIMINARY RESULTS.
Tleimat and Associates, Alamo, CA.
For primary bibliographic entry see Field 3C.
W90-08055

CHARACTERISTIC FEATURES OF DESALINATION PLANTS WITH THIN FILM HEAT EXCHANGERS.
Dal'nevostochnyi Politekhnicheskii Inst., Vladivostok (USSR).
V. Slesarenko.
Desalination DSLNAH, Vol. 74, No. 1/3, p 305-316, November 1989. 6 fig, 6 ref.

Descriptors: *Desalination plants, *Economic aspects, *Evaporators, *Comparison studies, Heat exchange, Mathematical equations, Performance evaluation, Theory, Water treatment.

The productivity, metal capacity, and economy of desalination plants depends on the correct estimation of such processes as hydrodynamics and heat exchange in the evaporated film under low pressure. A comparative analysis of various film generalization methods was conducted. In the first evap-

orator, hydrodynamics and heat exchange were studied in an ascending thin film current formed by air and steam or fed into tubes through nozzles. The second evaporator studied was a heat exchanger with descending seawater film motion along the vertical heat surface with change nozzles at the top of the tube. The third plant was formed of vertical rows of horizontal tubes, with the evaporated water discharged at free or pressure spray conditions with special sprayers. The fourth plant was a vertical tube heat exchanger with built-in special sprayers with diameter less than that of the main tube. The experiments showed that the vapor at the descending film current was accompanied by the evaporation from its surface and developed boiling bubbles; its defining values are heat current, spray density, and water and pressure properties. Theoretical analysis showed that the vapor apparatus capacity with the descending film flow increases with the heat current growth, and the spray density change influences this index insignificantly. Experiments showed that the horizontal film evaporators have the most heat change insensitivity at a rather high current stability of a liquid film. An equation was developed for describing the heat exchange process at any type of thin-film desalination plant. (Rochester-PTT)
W90-08056

SIMULATION OF MSF DESALINATION PLANTS.
King Saud Univ., Riyadh (Saudi Arabia). Dept. of Chemical Engineering.
I. S. Al-Mutaz, and M. A. Soliman.
Desalination DSLNAH, Vol. 74, No. 1/3, p 317-326, November 1989. 3 fig, 2 tab, 11 ref.

Descriptors: *Desalination, *Flash distillation, *Model studies, *Saudi Arabia, *Simulation, Computers, Performance evaluation, Water treatment.

A very fast, steady-state simulation method was developed for multi-stage flash (MSF) desalination plants based on the method of orthogonal collocation. Instead of solving mass and heat balances for all stages, very few selected stages were solved. The stages are chosen to be at the roots of a suitable orthogonal polynomial. Data from the Al-Khobar II MSF plant, Saudi Arabia, were used. Calculations show that the method is remarkably efficient and at least two times faster than a method based on the simultaneous solution of all stages of mass and heat balances. The tridiagonal method took 1.6 sec central processor unit time on a VAX 785 computer, whereas the new method took 0.8 sec. (Rochester-PTT)
W90-08057

TRANSIENT MODEL OF MULTISTAGE FLASH DESALINATION.
Kuwait Univ., Safat. Dept. of Chemical Engineering.
M. A. Rimawi, H. M. Ettouney, and G. S. Aly.
Desalination DSLNAH, Vol. 74, No. 1/3, p 327-338, November 1989. 8 fig, 1 tab, 11 ref.

Descriptors: *Desalination, *Flash distillation, *Model studies, *Simulation models, Brines, Performance evaluation, Saline water, Temperature, Transient behavior, Water treatment.

A theoretical model was developed to simulate transient behavior of multistage flash desalination. The model involves simultaneous solution of the mass and energy balance equations in all separation stages. Each stage is defined by nine variables: heights of flashing brine and distillate, salt concentration in the flashing brine, brine and distillate flow rates, flashing pressure, and temperatures of the flashing brine, distillate, and feed brine. Results of a case study for a once-through multi-stage configuration show rapid and nonlinear variation in the heights of the brine and distillate pools. Variation in the brine temperature is less pronounced than the distillate temperature because of the small amount of distillate. (Rochester-PTT)
W90-08058

ELECTROSTATICALLY ENHANCED EVAPORATION RATES OF SALINE WATER.

Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources.
N. N. Barthakur.
Desalination DSLNAH, Vol. 74, No. 1/3, p 339-353, November 1989. 3 fig, 1 tab, 18 ref. Natural Sciences and Engineering Research Council of Canada Grant OGP0010245.

Descriptors: *Desalination, *Distillation, *Evaporation, *Saline water, Electric wind, Electrical studies, Entropy, Potassium chloride, Temperature, Thermodynamics.

Corona-produced air ions of each polarity were used to evaporate to dryness samples of KCl solutions of 10, 15, and 20% (w/v) concentrations. Surface drying times were determined with a beta-ray gauge. Samples exposed to fluxes of either 1.8 x 10 to the 12th power positive or 4.20 x 10 to the 12th power negative air ions per sq cm per sec dried 2.5-3.9 times faster than control samples under different relative humidity conditions in the laboratory. Evaporation rate enhancement of solutions, exposed to bipolar air ions, occurred at an equilibrium temperature that was about 6 C lower than the ambient temperature. Electric wind caused by the ionic drag is proposed as the principal driving force for the observed enhancement of evaporation. Thermodynamic considerations showed that a concentration gradient developed in the solution with the highest concentration at directly below a single point electrode where nucleation and crystallization of the solution first occurred. An entropic effect also led to an exothermic process, which partly explained the low temperature obtained by the exposed solution compared to the temperature of a freely evaporating sample. (Author's abstract)
W90-08059

INHIBITION EFFICIENCY OF SCALE FORMATION BY CHEMICAL ADDITIVES.
Akademiya Nauk SSSR, Sverdlovsk. Inst. of Physical Chemistry.
O. D. Linnikov, V. L. Podbereznyi, M. A. Belyshev, V. M. Balakin, and V. S. Talankin.
Desalination DSLNAH, Vol. 74, No. 1/3, p 355-361, November 1989. 4 fig, 3 ref.

Descriptors: *Desalination apparatus, *Saline water, *Scaling, Additives, Chemical water treatment, Performance evaluation, Phosphonates, Polyelectrolytes.

Comparative tests were conducted of a number of chemical additives-scale formation inhibitors, of phosphonate, polyelectrolyte type, and others being used in the USSR and abroad. The processes of magnesium hydroxide, calcium carbonate, and sulfate scale formation were simulated in laboratory apparatus. To eliminate mutual superposition of scale formation processes of different types, which is inevitable in seawater use, simulated solutions were applied. The most efficient chemical additives for inhibition of these types of scale were determined. Most of the additives had little effect on magnesium hydroxide scale formation. The most efficient inhibitor of calcium carbonate scale formation was the phosphonate; for calcium sulfate the most efficient inhibitor was nitrilotrimethylene phosphonic acid (NTP). Inhibition of magnesium hydroxide scale was observed with oxyethyliden-diphosphonic acid (OEDP), NTP, and sodium polyphosphate, but their efficiency was not high. (Rochester-PTT)
W90-08060

HEAT TRANSFER IN THIN FILM-TYPE EVAPORATOR WITH PROFILED TUBES.
Kiev Polytechnic Inst. (USSR).
V. G. Rifert, V. L. Podbereznyi, J. V. Putilin, J. G. Nikitin, and P. A. Barabash.
Desalination DSLNAH, Vol. 74, No. 1/3, p 363-372, November 1989. 4 fig, 7 ref.

Descriptors: *Desalination apparatus, *Evaporators, *Heat transfer, Desalination, Design criteria, Mathematical analysis, Performance evaluation, Water treatment.

Local and average heat-transfer coefficients in water film evaporation on horizontal profiled tubes

were measured. Dependencies for calculating the average heat transfer are presented. The studies showed that the use of longitudinally-profiled tubes makes it possible to increase, with an account of development of the heat-exchange surface, the heat transfer from the wall to the film of the down-flowing liquid by a factor of 1.35-1.85 and the overall 'vapor-liquid' heat transfer of 1.3-1.5. Based on these results such tubes can be recommended for use in desalination plant evaporators. (Author's abstract)
W90-08061

HEAT EXCHANGE AT DROPWISE CONDENSATION IN HEAT EXCHANGERS OF DESALINATION PLANTS.
Kiev Polytechnic Inst. (USSR).
V. G. Rifert, A. I. Sardak, S. V. Grigorenko, and V. L. Podbereznyj.
Desalination DSLNAH, Vol. 74, No. 1/3, p 373-382, November 1989. 5 fig, 5 ref.

Descriptors: *Condensation, *Desalination plants, *Heat transfer, Design criteria, Performance evaluation, Seawater, Water vapor.

Heat exchange was studied experimentally at a dropwise steam condensation in a horizontal using a stimulant (fluorine-containing disulfide). The use of this stimulant increased the heat transfer 2-9 times versus film condensation. The effect of the heat flux density, steam velocity, condensate onflow, temperature of condensate, and noncondensable gases on the behavior of the process were studied. Commercial-scale studies were conducted with the arrangement of the process dropwise steam condensation on the outside surface of a horizontal tube. The studies were aimed at determining the duration and quality of dropwise condensation at a single treatment of the heat-exchange surface as well as at searching the methods for producing a coating under commercial operating conditions. The brass-tube heat exchanger was installed in the seawater preheating line of a 10-effect desalination plant of a desalination complex. During 800 hr of operation of the maximum increase in heat transfer intensity was 2.5-2.7 times; after 700 hr of operation this decreased to 1.5. Changing the ratio of components of the hydrophobic composition made it possible to reduce the flow rate to 3.8 g/sq m while ensuring stable dropwise condensation on the surfaces of the tubes. Only near the steam inlet union did dropwise condensation change over to film, with film movement along the horizontal tube. (Rochester-PTT)
W90-08062

INFLUENCE OF SPRAY DENSITY OF COEFFICIENT OF GAS DYNAMIC RESISTANCE FOR TUBE BUNDLES OF DIFFERENT CONFIGURATION.
Akademiya Nauk SSSR, Sverdlovsk. Inst. of Physical Chemistry.
V. V. Ilyushchenko, V. L. Podbereznyi, and S. I. Golub.
Desalination DSLNAH, Vol. 74, No. 1/3, p 383-389, November 1989. 3 fig, 1 tab.

Descriptors: *Condensation, *Desalination, *Water vapor, Air currents, Gas dynamic resistance, Mathematical studies, Performance evaluation, Tube bundles.

The effect of spray density on gas dynamic resistance was investigated on a test model for tube bundles of different configurations with air flow cross and cocurrent with fluid rejection of vapor. The arrangement of smooth and profiled tubes at different diameters in the bundle was staggered and in-line. A considerable increase was observed in gas dynamic resistance coefficient with the increase of spray density for cross vapor rejection from the tube bundle, whereas for cocurrent vapor flow this dependence was slight. Empirical coefficients were obtained for all types of tube bundles tested (25, 38, and 52 mm diameter). These coefficients permit the calculation of their gas dynamic resistance from the published equation. (Author's abstract)

W90-08063

INTERACTION OF SPRAYING LIQUID AND VAPOUR IN HORIZONTAL-TUBE FILM EVAPORATORS.
Akademiya Nauk SSSR, Sverdlovsk. Inst. of Physical Chemistry.
V. V. Ilyushchenko, V. L. Podbereznyi, and S. I. Golub.
Desalination DSLNAH, Vol. 74, No. 1/3, p 391-400, November 1989. 4 fig, 2 ref.

Descriptors: *Condensation, *Desalination, *Evaporators, *Model studies, *Water vapor, Film evaporators, Mathematical analysis, Performance evaluation, Pilot plants, Tube bundles.

Uniform spraying of liquid over the surface and height of a tube bundle is important for operation of horizontal-tube film evaporators (HTFEs). A mathematical model was developed to calculate the uniformity of liquid distribution in a tube bundle with cross vapor rejection. The model permits the mass of spraying liquid over any tube of the bundle and the liquid bulk rejected by vapor from heat exchange to be defined. The theoretical development of model equations is presented and results of an experimental pilot plant study are described. These results demonstrate that, in horizontal vapor rejection from large tube bundles, it is necessary to take into account liquid overflow in the tube bundle. An equation is included here that may be used to calculate flow rate of spraying liquid on any tube in the HTFE tube bundle depending on operation parameters and apparatus size. (Rochester-PTT)
W90-08064

DISTRIBUTION OF HALOMETHANES IN POTABLE WATERS OF KUWAIT.
Liverpool Univ. (England). Dept. of Oceanography.
For primary bibliographic entry see Field 5F.
W90-08399

REVERSE OSMOSIS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W90-08502

ELECTRODIALYSIS.
Toulouse-3 Univ. (France). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W90-08505

3B. Water Yield Improvement

PROGRAMME AL GHAIT–MOROCCO WINTER SNOWPACK AUGMENTATION PROJECT: A COOPERATIVE PROJECT BETWEEN THE KINGDOM OF MOROCCO AND THE UNITED STATES.
Bureau of Reclamation, Denver, CO. Div. of Research and Lab. Services.
D. A. Matthews, A. S. Dennis, C. L. Hartzell, J. G. Medina, and P. Goorian.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-147232. Price codes: A11 in paper copy, A02 in microfiche.
Report No. R-89-14, September 1989. 236p, 61 fig, 38 tab, 73 ref, append.

Descriptors: *Cloud seeding, *Governmental interrelations, *Morocco, *Snowpack, *Water resources development, *Weather modification, Atlas Mountains, Cloud liquid water, Oum er Rbia River, Streamflow, Supercooling, Temperature.

From 1984 to 1989 the Governments of Morocco and the United States cooperated in Programme Al Ghait, a $12,000,000 project to investigate the feasibility of augmenting water supplies in Morocco through weather modification. A demonstration project was set up in the upper Oum er Rbia basin, which is on the northwestern side of the central

High Atlas Mountains. Promising cloud formations were treated with silver iodide released from aircraft and, beginning in 1987, from a network of ground-based generators. Clouds were seeded on 144 days over the five winters of operations. Seedable conditions, as indicated by the presence of supercooled liquid water in clouds at concentrations up to 0.7 g/cu m at temperatures down to -12 C, were found to occur on 15 to 30 days per winter. The evaluation studies, which were based on a target-control design using streamflow as the response variable, indicated that 6 years of experimentation would be required to provide a 50% probability of detecting a 10% increase in streamflow due to seeding. The potential effects of augmented streamflow upon the operation of the Oum er Rbia River and upon the local and national economy were studied with the aid of computer models. This report covers the project design, the contributions of the two Governments involved, the development of Moroccan institutions to handle such a complex program, the technology transfer and scientific studies accomplished, and the results of the streamflow and economic analyses using models. A section on problems encountered and lessons learned is included for the benefit of other persons or agencies contemplating large, complex projects involving more than one national government. (Lantz-PTT)
W90-08165

ECONOMIC EFFECTS OF PRECIPITATION ENHANCEMENT IN THE CORN BELT.
Illinois State Water Survey Div., Champaign. Climate and Meteorology Section.
P. Garcia, S. Changnon, and M. Pinar.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 1, p 63-75, January 1990. 1 fig, 8 tab, 20 ref, append.

Descriptors: *Artificial precipitation, *Corn belt, *Economic impact, *Water supply development, *Weather modification, Cattle, Corn, Crop production, Government finance, Government interrelations, Hogs, Humid climates, Marketing, Potential water supply, Poultry, Profit, Soybeans, Taxes, Water use.

Policy formulation in weather modification requires an understanding of the economic effects from altered weather. An insight is needed into the beneficiaries of a functioning weather modification technology when applied at various spatial and temporal levels. An econometric model which links the corn/soybean production to U.S. cattle, hog, and poultry sectors is used to determine the effects of precipitation enhancement in the U.S. Corn Belt, a humid climatic region. A regional supply formulation permits assessment of weather modification on production, prices, and revenues to producers, and savings in consumers' expenditures on meat. From the perspective of the producers in a target area, the increase in revenue from added precipitation over time favors multiyear use of the precipitation modification technology. The sentiment among producers, given the highly variable nature of revenue from precipitation modification across areas, seems to be that the most direct beneficiaries of the technology should support its operation and maintenance. The nature of the changes in producer revenues and the findings that consumers benefit from modification technologies and the potential use of precipitation modification technologies across regions support the concept that funding responsibilities for research and development should fall on more aggregate government units, i.e., state and federal. It is clear that large-scale precipitation modification reduces the revenues to producers making its use less attractive, so should be coordinated with market expansion and demand creation strategies so that the profitability of these new technologies may be maintained. (Author's abstract)
W90-08198

3C. Use Of Water Of Impaired Quality

CHEMICAL EFFECTS OF SALINE IRRIGATION WATER ON A SAN JOAQUIN VALLEY SOIL: I. COLUMN STUDIES.

California Univ., Riverside. Dept. of Soil and Environmental Sciences.
C. Thellier, B. Sposito, and K. M. Holtzclaw.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 50-55, 1990. 5 fig, 2 tab, 25 ref. Univ. of California Water Resources Center Project UCAL-WRC-W-632.

Descriptors: *California, *Irrigation effects, *Saline groundwater, *Saline soils, *Soil tests, Aquifers, Chemical analysis, Conductivity, Laboratory methods, Physicochemical properties, Saline water.

A glasshouse soil column experiment was performed to characterize salinity and sodicity developed from waters of differing composition applied to a representative soil from the San Joaquin Valley of California. The experiment was designed to simulate physicochemical conditions in a field experiment conducted in the western San Joaquin Valley, where an Entisol above a shallow, saline aquifer was irrigated with waters of varying quality. Columns 0.46 m long containing the Entisol were leached with 'California Aqueduct water' (electrical conductivity (EC) = 0.72 dS/m, sodium adsorption ratio (SAR) = 4 mol sub c to the 0.5 power, per meter to the 1.5 power) or with saline 'well water' (EC = 8 ds/m, SAR = 13 mol sub c to the 0.5 power, per meter to the 1.5 power) for periods up to 1 year. When a simulated 'aquifer' was 0.43 m below the soil surface, leaching with aqueduct water produced a positive downward gradient of soluble salt concentrations and exchangeable Na, whereas leaching with well water produced a dramatic increase of sodicity at the soil surface and a zone of soluble bivalent cation accumulation about 0.2 m below. After the simulated 'aquifer' was withdrawn, soil saturation extracts indicated equilibration with the applied waters after 0.5 to 1 year. The saturation extract and drainage effluent for the soil receiving aqueduct water became more dilute, producing calcite dissolution and increasing exchangeable Ca, with a consequent decline in sodicity. The soil receiving well water showed an increase in exchangeable Na at the expense of exchangeable Ca, with little or no change in exchangeable potassium and magnesium. Soil irrigated with well water became more saline and sodic but, since EC was sufficiently high as compared to SAR, no major permeability problems with the soil were expected. Therefore, reuse of saline drainage water would appear to be suitable for agricultural purposes provided that salt-tolerant crops were grown. (See also W90-07699) (Author's abstract)
W90-07698

CHEMICAL EFFECTS OF SALINE IRRIGATION WATER ON A SAN JOAQUIN VALLEY SOIL: II. FIELD SAMPLES.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
C. Thellier, K. M. Holtzclaw, J. D. Rhoades, and G. Sposito.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 56-60, 1990. 5 tab, 13 ref. Univ. of California Water Resources Center Project UCAL-WRC-W-632.

Descriptors: *California, *Irrigation effects, *Saline soils, *Saline water, *Soil tests, Chemical analysis, Conductivity, Cotton, Cropland, Field tests, Physicochemical properties, Saline groundwater, Sugar beets, Wheat.

Representative samples were collected from the surface horizon of an Entisol in field plots that had received applied waters of differing quality over a 5-year period while cropped with cotton (Gossypium sp.), wheat (Triticum sp.), and sugarbeets (Beta vulgaris L.). Irrigation was either with California Aqueduct water, saline well water, or a 1:1 mixture of the two. The soil samples were analyzed for saturation extract electrolytic conductivity (EC sub e); soluble and exchangeable cations; and carbonate and gypsum content. Both salinity and sodicity increased in the soil samples with decreasing applied water quality, and all of the samples were more saline and sodic and contained more calcite than at the initiation of the field

experiment. The samples from plots receiving well water had developed values of EC sub e and sodium absorption ratio (SAR sub e), as well as an exchangeable sodium percentage-SAR sub e relationship, identical to those observed after 1 year in a companion soil column experiment. The samples from plots receiving aqueduct water were more saline and sodic than in the corresponding soil column experiment, however, probably because of less effective leaching in the field experiment. These results confirmed the hypothesis that the chemical properties of the field soils would be determined by the interplay between the applied water and evaporative capillary rise from the shallow aquifer. Since the increased salinity of the soil samples compensated for their increased sodicity, no permeability problems were expected,and irrigation with saline water should be successful for salt-tolerant corps if leaching were adequate. (See also W90-07698) (Author's abstract)
W90-07699

EVALUATION OF LAND APPLICATION USING SECONDARY EFFLUENT IN A FOREST SLOPE: ESTIMATION OF DRAINED WATER QUALITY AND DISCUSSION OF THE EFFECTS UPON SOIL OR PLANTS AND BEHAVIOR OF BACTERIA.
Kagawa Univ., Takamatsu (Japan).
For primary bibliographic entry see Field 5E.
W90-07908

RECIPROCAL RECYCLING.
Camp, Dresser and McKee, Inc., Clearwater, FL.
L. R. Tortora, and M. A. Hobel.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 1, p 66-68, January 1990.

Descriptors: *Cooling water, *Recycling, *Wastewater renovation, *Wastewater utilization, *Water reuse, Economic aspects, Florida, Pennsylvania, Reclaimed water, Wastewater disposal, Wastewater treatment.

In Hillsborough County, Florida the wastewater treatment plant is located next to an energy recovery facility. The county uses reclaimed wastewater from the treatment plant as cooling water for the energy recovery facility. This combination of processes provides benefits for both plants: an inexpensive source of cooling water for energy recovery and expanded capacity for the wastewater treatment plant. The energy recovery facility not only provides a use for the reclaimed water, but also creates an alternative to surface water discharge, helping to protect sensitive Tampa Bay and the area's lakes and streams from effluent nutrient loads. Use of the reclaimed water is economical for the recovery facility and conserves groundwater and potable water. The wastewater treatment plant solves another waste-disposal problem by providing treatment of the energy recovery cooling water and boiler blow-down. The county saves about $2 million in costs for wastewater treatment while the energy recovery system saves approximately $260,000 in costs for potable water supplies. In Lancaster County, Pennsylvania, the Solid Waste Management Authority has an intergovernmental agreement with neighboring Elizabethtown Borough which allows the authority's waste-to-energy incineration facility to come on line in 1991, receiving all of its nonpotable supply from the Elizabethtown secondary wastewater treatment plant. The treatment plant effluent outflow to the Susquehanna River passes within approximately 1 mile of the incinerator site. Effluent intercepted from this outflow at the closest point can service the incinerator's nonpotable requirements. The incineration facility will store 2.5 million gallons of water on site, enough to operate the facility for three days in the event of interrupted service at the wastewater treatment plant. Wastewater will be treated at the waste-to-energy facility in a zero-discharge system with all effluent recycled for on-site nonpotable use. (Geiger-PTT)
W90-07961

NOVEL 2500 GPD 5-EFFECTS WIPED-FILM ROTATING-DISK VAPOR-COMPRESSION MODULE: PRELIMINARY RESULTS.

Tleimat and Associates, Alamo, CA.
B. Tleimat, and M. Tleimat.
Desalination DSLNAH, Vol. 74, No. 1/3, p 289-303, November 1989. 5 fig, 3 tab, 10 ref.

Descriptors: *Desalination, *Evaporators, *Wastewater renovation, *Water reuse, Agricultural water, California, Distillation, Drainage water, Heat, Performance evaluation, Saline water, Water treatment, Wiped-film rotating disk vapor compressi.

A laboratory model wiped-film rotating disk (WFRD) vapor-compression evaporator with a capacity of 300 L/day was conceived, designed, and built in the late 1960s at the Sea Water Conversion Laboratory, University of California at Berkeley. Preliminary data obtained from this model showed an exceptionally high overall heat transfer coefficient, U, in excess of 28 kW/sq m C (5000 Btu/hundred sq ft F). Results from later data with precise instrumentation confirmed the earlier results and showed even higher values for U. Thermoeconomic analysis of multieffect vapor-compression (VC) systems to reclaim 95% of agricultural drainage water at the San Joaquin Valley in California showed that the use of multi-effect VC systems reduces energy consumption. It also showed that the ratio of U in the evaporator to its cost per unit area of heat transfer has a very strong influence on distilled water cost: the higher the ratio, the lower the distilled water cost. Because of the exceptionally high value of U in the WFRD evaporator and based on data obtained from the laboratory model at Los Banos, California, using agricultural drainage water, its use in a five-effect VC system will reduce the product water cost by a factor of two and energy consumption by a factor of three compared to off-the-shelf single-effect conventional VC systems. A semi-commercial 2500-gal/day five-effect VC WFRD evaporator module was designed, built, and tested with tap water. Preliminary data showed an average value of U to be about 20 kW/sq m C (3500 Btu/hundred sq ft F) and energy consumption by the compressor between 3.6 and 5.1 kWh/cu m (13.6-19.3 kWh/1000 gal) of product water. (Author's abstract)
W90-08055

APPLICATIONS OF DEEP BED FILTRATION IN WASTEWATER TREATMENT.
Tokyo Univ. (Japan). Dept. of Urban and Sanitary Engineering.
For primary bibliographic entry see Field 5D.
W90-08498

3D. Conservation In Domestic and Municipal Use

SAVING COSTS WITH RESERVOIR PUMPED-WATER INTERTIES.
Ohio State Univ., Columbus. Dept. of Civil Engineering.
E. E. Whitlatch.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 3, p 45-48, March 1990. 4 fig, 2 tab, 5 ref.

Descriptors: *Operating costs, *Reservoir operation, *Water transport, *Water yield improvement, Case studies, Columbus, Cost analysis, Interbasin transfers, Ohio, Pumped storage, Reservoir yield, Safe yield, Water conservation, Water conveyance, Water supply development.

The interconnection of reservoirs through pumped-water or gravity interties can lead to cost savings and increased system safe yield. This principal is illustrated in the case study of the city of Columbus, Ohio, where a 3.8-mile pipeline was constructed from Alum Creek Reservoir, owned by the U.S. Army Corps of Engineers, to Hoover Reservoir, a city-owned water supply source. Simulation tests and mathematical optimization were used to ensure that the planned policies, when implemented, would provide the draft rate and reliability level appropriate for the reservoirs involved. Through careful timing of the transfer of water from Alum Creek Reservoir to Hoover Res-

ervoir, an increase of 34.3 mgd in the safe yield of Hoover Reservoir was achieved with an average pumpage of only 22.5 mgd. Because transferred water and Hoover Reservoir water cost less to treat than alternative sources, a net savings of $695,135 per year was realized in total water system operating costs. (Author's abstract)
W90-07894

POST-COMPLETION APPRAISAL: A TOOL FOR WATER INDUSTRY MANAGEMENT.
For primary bibliographic entry see Field 6B.
W90-07899

3F. Conservation In Agriculture

PESTICIDE CONTAMINATION OF GROUND WATER ARTIFICIALLY RECHARGED BY FARMLAND RUNOFF.
Nebraska Univ., Lincoln. Inst. of Agriculture and Natural Resources.
For primary bibliographic entry see Field 5B.
W90-07606

ASSESSMENT OF IRRIGATION TECHNOLOGY PERFORMANCE IN THE SOUTHERN SAN JOAQUIN VALLEY OF CALIFORNIA.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
H. J. Vaux, D. F. Handley, and P. M. Giboney.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 35-41, January 1990. 8 tab, 23 ref.

Descriptors: *Agricultural water, *California, *Drip irrigation, *Irrigation efficiency, Border irrigation, Evapotranspiration, Furrow irrigation, Irrigation practices, San Joaquin Valley, Soil moisture, Sprinkler irrigation, Water conservation.

There exists a substantial body of experimental evidence to support the proposition that adoption of sprinkler and drip irrigation systems may lead to significant savings in the quantities of water required to irrigate crops. Seasonal applied water measurements were obtained for 1710 irrigated fields in the southern San Joaquin Valley of California. Most of the fields were planted to one of five major crops: citrus, almonds, grapes, cotton, and small grains. These crops were irrigated with a wide array of irrigation technologies, including drop, sprinkler, furrows with tailwater reuse facilities, conventional furrows, and border irrigation systems. The data were analyzed within an accounting framework to standardize for a variety of climatic and cultural variations. Analyses of the mean depths of applied water by crop and irrigation technology and of the standardized results reveal that drip irrigation systems were associated with the lowest levels of applied water on permanent crops and that the levels of water applied with sprinklers did not differ significantly from those applied with surface systems on either permanent or annual crops. (Author's abstract)
W90-07637

EFFECTS OF DIFFERENT AMOUNTS OF WATER ON THE TOMATO CROP (LYCOPERSICON ESCULENTUM MILL.): II. EVAPO-TRANSPIRATION-GROWTH-NUTRITION RELATIONSHIPS, (EFFECTOS DE DIFERENTES ALTURAS DE AGUA SOBRE EL CULTIVO DEL TOMATE (LYCOPERSICON ESCULENTUM MILL.) II. RELACION EVAPOTRANSPIRACION-CRECIMIENTO-NUTRICION).
Instituto de Investigaciones Agropecuarias, Santiago (Chile).
R. Ferreyra, J. Tosso, and R. Ruiz.
Agricultura Tecnica AGTCA9, Vol. 49, No. 3, p 211-215, September 1989. 11 fig, 8 ref. English summary.

Descriptors: *Crop production, *Irrigation efficiency, *Tomatoes, Climates, Fertilizers, Nutrients, Root depth, Soil types.

During 1983/84, a field experiment was carried out at La Platina Research Station (Instituto Nacional de Investigacion para la Agricultura, Santiago,

Chile). Treatments were 11 water application rates, using the simple line sprinkler system. Results indicated that the roots of the crop were mainly in the first 60 cm of soil. This knowledge, in conjunction with previously-determined crop coefficients give the necessary elements to develop irrigation programs for this species. It was found that variations in the percentage of N and K were minor with respect to crop yield. The results make it possible to manage both irrigation and fertilization practices according to climate and soil conditions and expected crop yield. (Author's abstract)
W90-07661

OPTIMAL MULTICROP ALLOCATION OF SEASONAL AND INTRASEASONAL IRRIGATION WATER.
Indian Agricultural Research Inst., New Delhi. Water Technology Center.
N. H. Rao, P. B. S. Sarma, and S. Chander.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 551-559, April 1990. 1 fig, 5 tab, 24 ref.

Descriptors: *Irrigation efficiency, *Irrigation requirements, *Model studies, *Water allocation, Intraseasonal competition, Mathematical models, Multicrop irrigation, Seasonal competition, Single crop irrigation.

The problem of allocation of a limited water supply for irrigation of several crops grown in the same season is addressed. Both seasonal and intraseasonal competition for water between crops are considered. Since intraseasonal irrigation decisions are not independent, the allocation problem is solved in a dynamic framework by decomposition to two levels, seasonal and intraseasonal competition for water. A single crop irrigation scheduling model provides the input to the models at both levels. The optimization models at the two levels and the single crop model are solved by dynamic programming. Economic coefficients, crop areas, and crop growth stage stress effects are included in the mathematical formulation at both levels. The final output is an implementable set of weekly irrigation programs of individual crops. The decomposition of the multicrop water allocation problem reduces its dimensionality at the expense of solving the single-crop model several times, and the computational effort is reduced significantly. (Author's abstract)
W90-07666

OPTIMAL CONTROL METHOD FOR REAL-TIME IRRIGATION SCHEDULING.
Georgia Inst. of Tech., Atlanta.
A. L. Protopapas, and A. P. Georgakakos.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 647-669, April 1990. 8 fig, 19 ref, append.

Descriptors: *Crop yield, *Irrigation operation, *Model studies, Case studies, Decision making, Mass balance models, Root zone, Salinity, Soil moisture.

A systematic methodology for making real-time irrigation decisions is presented. A physically based representation of the dynamics of the soil-crop-atmosphere system is used. The variables characterizing the crop and soil status are concurrently simulated with an integrated state space model. Soil moisture and salinity conditions, which synergistically control the plant water uptake, are obtained by using lumped parameter mass balance models for the root zone. Crop yield is predicted by explicitly modeling the plant growth processes, such as assimilation, respiration, and transpiration, which are driven by the climatic inputs. The control model is an analytical optimization method for multistage multidimensional sequential decision-making problems. It is suitable for systems with nonlinear dynamics and objective functions. The method is based on local iterative approximations of the nonlinear problem with a linear quadratic problem. This approach is evaluated in a series of case studies, where optimal irrigation schedules are obtained on an hourly basis over the growing season. (Author's abstract)
W90-07674

CHEMICAL EFFECTS OF SALINE IRRIGATION WATER ON A SAN JOAQUIN VALLEY SOIL: I. COLUMN STUDIES.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 3C.
W90-07698

CHEMICAL EFFECTS OF SALINE IRRIGATION WATER ON A SAN JOAQUIN VALLEY SOIL: II. FIELD SAMPLES.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 3C.
W90-07699

AMERICA'S IRRIGATION: CAN IT LAST.
Agricultural Research Service, Fort Collins, CO.
J. van Schilfgaarde.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 3, p 67-69, March 1990.

Descriptors: *Irrigation effects, *Water demand, *Water pollution sources, *Water resources management, Agricultural water, Environmental policy, Heavy metals, Pollutants, Public policy, Salination.

Irrigated agriculture has made a substantial contribution to world food production for thousands of years. However, virtually all irrigation enterprises are now threatened by the same problems. Irrigation in arid or semiarid regions always degrades water quality. Without proper management, the land becomes waterlogged and salinized. Regardless of management, the drainage water from irrigated lands carries salt that requires disposal. For years, scientists and engineers have studied the effect of salinity on irrigation, but since the problem at Kesterson Reservoir in the San Joaquin Valley, the issue of contaminants within the drainage water, not salinity, has become a much more serious concern. Whereas the biological damage noted at Kesterson was attributed to selenium, high concentrations of other trace elements (including molybdenum, arsenic and boron) have since been found in drainage waters. As a result public and political sentiment is moving toward greater protection of the environment and less preferential treatment of irrigation. It cannot be assumed that irrigated agriculture is a protected and preferred practice and that its waste products must be accepted unconditionally by the public. Successfully maintaining irrigated agriculture can be achieved at a price; whether society is willing to pay the price cannot be taken for granted. (White-Reimer-PTT)
W90-07711

FIELD CONDITIONS AT THE MARICOPA AGRICULTURAL CENTER, PINAL COUNTY, ARIZONA, SEPTEMBER 28, 1989.
Geological Survey, Tucson, AZ. Water Resources Div.
S. J. Owen-Joyce.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-590, 1989. 12p, 3 fig, 2 tab, 3 ref.

Descriptors: *Agriculture, *Arizona, *Cropland, *Data collections, *Land use, *Remote sensing, Photography.

Field conditions were documented during the Landsat and SPOT satellite overpasses of the Maricopa Agricultural Center, Pinal County, Arizona, on September 28, 1989. Crop types were mapped and photographed for each demonstration farm field, and irrigation, cultivation, and orientation of rows are described. Field and photographic descriptions are presented in tabular and graphic form. (USGS)
W90-07848

USE OF THE ROPE-WASHER PUMP IN MICRO-SCALE IRRIGATION.
Loughborough Univ. of Technology (England).
R. D. Faulkner, and R. A. Lambert.

Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 88, No. 1, p 81-90, February 1990. 9 fig, 4 ref.

Descriptors: *Irrigation practices, *Pumps, *Zimbabwe, Developing countries, Hydraulic machinery, Irrigation, Irrigation efficiency.

The rope-washer pump, an adaptation of the older chain-and washer pump, was modified to fill the technology gap between the water-can and the diesel pump in Zimbabwe for single farmer irrigation. The pump is low in cost and can be manufactured and maintained at the village level. Laboratory and field tests show that over the range of low heads for which it was primarily intended (up to 5 m), output flow rates of 1-2 L/sec are sustainable using human power, which is sufficient to irrigate a 0.25 ha plot by a single farmer. This output enables the farmer to produce up to twice the annual family food requirement. The volumetric efficiency of the pump is high (up to 95%), and the mechanical efficiency was generally in the 50-60% range for normal operating conditions. The optimum speed of the rope is about 0.6-0.8 m/sec to achieve high volumetric and mechanical efficiencies. In practice, at the preferred rotational speed of the pulley of 30 rpm, this led to a pulley diameter of 500 mm. The flow rate from the pump increases as the washer spacing on the rope is reduced, down to a spacing of 0.75 m beyond which there is no further increase. It was concluded that for practical purposes a washer spacing of 1.0 m is acceptable. (Geiger-PTT)
W90-07898

LYSIMETER STUDY OF THE EFFECTS OF A RYEGRASS CATCH CROP, DURING A WINTER WHEAT/MAIZE ROTATION, ON NITRATE LEACHING AND ON THE FOLLOWING CROP.
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France). Dept. de Biologie.
For primary bibliographic entry see Field 5G.
W90-07995

EFFECT OF WATER STRESS ON THE CANOPY ARCHITECTURE AND SPECTRAL INDICES OF IRRIGATED ALFALFA.
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
M. S. Moran, P. J. Pinter, B. E. Clothier, and S. G. Allen.
Remote Sensing of the Environment RSEEA7, Vol. 29, No. 3, p 251-261, September 1989. 8 fig, 4 tab, 16 ref.

Descriptors: *Alfalfa, *Canopy, *Irrigation effects, *Water stress, Arizona, Biomass, Leaves, Plant water potential, Reflectance, Remote sensing, Spectral analysis, Vegetation index.

Diurnal measurements of alfalfa leaf distribution and crop canopy reflectance were made in stressed and unstressed alfalfa plots in Phoenix, Arizona. Measurements were made on three dates in January, May, and November. Results showed that heliotropic leaf measurements were directly affected by crop water status. Under well-watered conditions, alfalfa leaves tended to track the sun throughout the day, in both the azimuthal and zenithal directions. In the stressed plots, diurnal tracking ability diminished as the day progressed and the canopy assumed a more vertical profile due to leaf cupping. The stressed canopy then had a lower spectral reflectance (measured at nadir) than the unstressed canopy, in both the red and near-IR wavebands. The Perpendicular Vegetation Index (PVI) decreased with the stress-induced change in architecture while the near-IR/red ratio remained relatively constant. As a result, the near-IR/red ratio was more successful in estimating alfalfa biomass than was the PVI. These results emphasize the need to account for stress-induced architectural differences in plant canopies when using remotely sensed spectral data. (Author's abstract)
W90-08016

Group 3F—Conservation In Agriculture

CORRELATIONS BETWEEN CANOPY RE-
FLECTANCE AND LEAF TEMPERATURE IN
IRRIGATED AND DROUGHTED SOYBEANS.
North Carolina State Univ. at Raleigh. Dept. of
Forestry.
W. W. Cure, R. B. Flagler, and A. S. Heagle.
Remote Sensing of the Environment RSEEA7,
Vol. 29, No. 3, p 273-280, September 1989. 4 fig, 2
tab, 22 ref.

Descriptors: *Canopy, *Drought effects, *Irriga-
tion effects, *Reflectance, *Soybeans, *Tempera-
ture, Air temperature, Correlation analysis,
Leaves, Remote sensing, Spectral data, Water
stress.

Effects of water stress on soybeans were character-
ized over a 4-day period in well-watered and
water-stressed plots by measurements of leaf tem-
perature, air temperature, and canopy reflectance.
The objectives were to assess canopy reflectance
as an indicator of drought stress in soybean and to
determine if canopy reflectance could be predicted
from leaf temperature. Reflectance from the water-
stressed plants was greater in the red portion of the
visible spectrum and less at near-infrared wave-
lengths. Correlation coefficients with the reflec-
tance measurements were generally greater with
leaf temperature than with either the air tempera-
ture within the canopy or the differential between
leaf and air temperatures. Coefficients of determi-
nation in excess of 0.8 could be obtained for
models predicting either red or near-infrared re-
flectance as a function of leaf temperature by ex-
cluding those measurements taken shortly after
irrigations. Plant size strongly affected model pa-
rameters. (Author's abstract)
W90-08017

WATER SUPPLY.
Environmental Protection Agency, Cincinnati,
OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5F.
W90-08181

SOCIO-ECONOMIC IMPACT OF IRRIGATION
DEVELOPMENT: A SOUTH AFRICAN EXPE-
RIENCE.
Orange Free State Univ., Bloemfontein (South
Africa). Dept. of Agricultural Economics.
M. F. Viljoen.
Water SA WASADV, Vol. 16, No. 1, p 5-12,
January 1990. 4 fig, 4 tab, 8 ref.

Descriptors: *Economic impact, *Irrigation ef-
fects, *Irrigation programs, *Social impact, *South
Africa, Economic development, Farming, Region-
al development, Resources development, Rural so-
ciology, Social aspects, Social needs.

A study was conducted to determine the socio-
economic impact of irrigation development for the
Vaalharts, South Africa, irrigation scheme which
was started in 1936. A multi-criteria interrelation-
ship approach was used, whereby different criteria
were used to measure the changes in various socio-
economic components and the interrelationships
among these components. By making use of this
approach and by comparing the Vaalharts area
with the control area, it was possible to determine
the impact of irrigation development on socio-
economic variables and social welfare aims. The
main conclusion was that irrigation development
had a major positive effect on most of the social
welfare aims considered, i.e., increased food pro-
duction, stabilized food production, independence
of food imports, earning of foreign currency, cre-
ation of existence opportunities to farmers, creation
of job opportunities, regional development, geo-
graphical distribution of welfare, establishment of
viable rural communities, and countering depopu-
lation of rural areas. (Author's abstract)
W90-08227

ANALYTICAL MODEL FOR FURROW IRRI-
GATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil
Engineering.
F. X. Yu, and V. P. Singh.
Journal of Irrigation and Drainage Engineering

(ASCE) JIDEDH, Vol. 116, No. 2, p 154-171,
March/April 1990. 5 fig, 3 tab, 25 ref.

Descriptors: *Drainage engineering, *Furrow irri-
gation, *Irrigation design, *Irrigation engineering,
*Model studies, *Surface irrigation, Calibration,
Cross-sections, Flow characteristics, Infiltration
rate, Storm seepage, Surface flow.

Borders and furrows are extensively used as sur-
face irrigation methods. Perhaps the most impor-
tant part of the surface irrigation system design and
evaluation is the control of the advance and reces-
sion phases. An analytical model is developed to
simulate all phases of furrow irrigation. The model
transforms any real furrow cross section shape to a
discharge-equivalent semicircular shape, and can
therefore be applied to any form of furrow cross
section. Parabolic shapes are used to describe the
surface and subsurface flow profiles and their coef-
ficients are determined from the conditions in the
gradually varied flow region, rather than in the
region of rapidly varied flow at the advance front.
Infiltration is simulated in three dimensions rather
than in one or two dimensions. The recession
phases are simulated by modifying Strelkoff's
model such that the time-varying rate of infiltra-
tion is taken into account. One observed data set is
used to calibrate the model, and six observed data
sets are used to verify it. The model is simple,
accurate (less than 8% deviation for all phases),
and easy to apply. (Author's abstract)
W90-08354

HOURLY ET MODEL CALIBRATION WITH
EDDY FLUX AND ENERGY BALANCE DATA.
Oklahoma State Univ., Stillwater. Dept. of Agri-
cultural Engineering.
For primary bibliographic entry see Field 2D.
W90-08355

EFFECTIVE RAINFALL ESTIMATION METH-
ODS.
Minnesota Univ., St. Paul. Dept. of Agricultural
Engineering.
For primary bibliographic entry see Field 2B.
W90-08356

EFFECTS OF CLIMATE CHANGE ON U.S. IR-
RIGATION.
Utah State Univ., Logan. Dept. of Agricultural
and Irrigation Engineering.
For primary bibliographic entry see Field 2B.
W90-08357

XIANGTAN Q-TYPE AUTOMATIC HYDRAU-
LIC FLAP GATE.
Xiangtan City Water Resources and Hydropower
Bureau (China).
L. G. Jiong.
Journal of Irrigation and Drainage Engineering
(ASCE) JIDEDH, Vol. 116, No. 2, p 211-218,
March/April 1990. 4 fig, 2 tab, 3 ref.

Descriptors: *Hydraulic engineering, *Hydraulic
gates, *Irrigation engineering, China, Developing
countries, Discharge coefficient, Electric power,
Flooding, Flow discharge, Maintenance costs,
Steel, Water level fluctuations.

The automatic operation of the Xiangtan Q-type
automatic flap gate (Q-type gate) is based on hy-
draulic pressure only. As the upstream water rises
above the top of the gate, the gate opens automati-
cally to safeguard the banks against flooding. As
the water level drops below the normal water
level, the gate begins to close to retain the water.
Hence it allows unmanned operation and requires
neither lifter nor electric power supply. The gate
arm is a simple rectangular plate turning along the
surface of bearing that is also a simple elliptical
plate made of common steel. Owing to simplicity
in nature, the cost of work is lower and skillful
maintenance is unnecessary. The Q-type gate can
operate in free outflow or in submerged flow. Its
discharge coefficient is analogous too, even larger
than that of a broad crest weir, and its capacity to
remove debris is better. The design of the key parts
of the Q-type gate requires solution of a curve

equation for the path of the overturning gate leaf
as the water level rises. Since 1980, a group of Q-
type gates have been installed on weirs and have
operated safely for 5-8 years without any damage.
The Q-type gate has many practical advantages
and is rather suitable for developing countries.
(Author's abstract)
W90-08358

LAND-GRADING DESIGN BY USING NON-
LINEAR PROGRAMMING.
Baghdad Univ. (Iraq). Coll. of Engineering.
S. N. Hamad, and A. M. Ali.
Journal of Irrigation and Drainage Engineering
(ASCE) JIDEDH, Vol. 116, No. 2, p 219-226,
March/April 1990. 3 fig, 2 tab, 13 ref.

Descriptors: *Drainage engineering, *Grading,
*Irrigation design, *Irrigation engineering, *Non-
linear programming, Earthworks, Gravity flow,
Land forming, Surface irrigation.

Land grading is an important and necessary oper-
ation for successful and efficient surface irrigation.
Currently, most lands are graded or reshaped to
form a plane surface with uniform slopes in one or
two directions. A new technique has been devel-
oped to perform land-grading designs by selecting
a best-fit curved or plane surface. The profiles of
such surfaces along either of the two major direc-
tions are assumed to be represented by a general
power function. The main goal of this technique is
to minimize the volumes of earthwork required
while obtaining a desirable smooth surface. Fur-
thermore, the fitted surface can be subjected to a
series of constraints: limiting the slope at any point;
choosing the desired surface shape, i.e., concave,
convex, or plane; and limiting the elevation of the
graded surface to allow gravity irrigation from a
water source. Nonlinear programming has been
used to perform the fitting procedure. The results
obtained from the developed procedure have been
compared with those obtained from previously
developed methods. The new procedure proved
efficient and very flexible in selecting a suitable
graded surface for a given land. (Author's abstract)
W90-08359

MONITORING AND EVALUATION OF IRRI-
GATION PROJECTS.
International Water Resources Association,
Oxford (England).
A. K. Biswas.
Journal of Irrigation and Drainage Engineering
(ASCE) JIDEDH, Vol. 116, No. 2, p 227-242,
March/April 1990. 1 fig, 5 ref.

Descriptors: *Irrigation engineering, *Irrigation
programs, *Water resources management, Apprais-
als, Evaluation, Monitoring, Project planning.

Monitoring and evaluation of irrigation projects
has been a neglected subject, but must play a more
important role in the future if the irrigation man-
agement process is to be improved. The process is
complex, since a large number of regular, specific
tasks must be performed, both concurrently and
sequentially, and coordinated by a variety of pro-
fessionals within available time and resource con-
straints. Monitoring and evaluation are needed for
a functional system, with a realistic framework for
carrying it out. For any evaluation to be used, it
must be credible: objective, accurate, and fair. Re-
ports should be clear, unambiguous, balanced in
terms of strengths and weaknesses, and contain
justifiable conclusions and recommendations. For
monitoring and evaluation to succeed, irrigation
managers need to develop a new evaluative mind-
set that enables them to appraise their projects'
performance objectively, reflect on what has been
learned for future use, and adjust policies on the
basis of that knowledge whenever necessary. (Au-
thor's abstract)
W90-08360

ESTIMATING IRRIGATION DIVERSIONS
FOR MAJOR TEXAS RICE-GROWING AREA.
Lower Colorado River Authority, Austin, TX.
Water and Wastewater Utilities Program.

Q. W. Martin.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 2, p 243-260, March/April 1990. 10 fig, 2 tab, 13 ref.

Descriptors: *Colorado River, *Diversion losses, *Estimating equations, *Irrigation engineering, *Irrigation requirements, *Rice, *Water conservation, Drought effects, Lake evaporation, Least squares method, Planting management, Potential water supply, Rainfall, Statistical analysis, Texas.

The Lower Colorado River Authority (LCRA) of Texas provides an average of 530,000 acre-ft annually for rice cultivation. To estimate water needs better, predictive equations were developed, using least squares regression, for the monthly and annual water diversions for the three largest rice irrigation systems served by LCRA. The equations provide statistically significant and physically meaningful relationships for predicting changes in water diversions with changes in rainfall, rice acreage planted, gross lake evaporation, and planting time of first crop rice. Depending on the particular irrigation system, the equations estimating annual diversions explain between 85% and 88% of the variation in the data, and those for monthly diversions explain between 47% and 81%, with the majority of these equations explaining better than 60%. These relationships developed may be used for drought contingency planning, evaluation of the impact of water conservation practices on water diversions, and estimation of the impact of using local supply sources, such as groundwater, on reducing river water diversion demands for irrigation. (Author's abstract)
W90-08361

CHARACTERIZING CYCLIC WATER-LEVEL FLUCTUATIONS IN IRRIGATION CANALS.
Yakima Indian Nation, WA.
K. C. Mitchell, L. G. James, S. Elgar, and M. J. Pitts.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 2, p 261-272, March/April 1990. 13 fig, 1 tab, 6 ref. Office of Naval Research contract number N00014-86-K-0877 and the National Science Foundation grant number OCE-8612008.

Descriptors: *Irrigation canals, *Irrigation engineering, *Seasonal variation, *Spectral analysis, *Water level fluctuations, Diurnal variation, Fourier analysis, Hydrologic cycle, Stage-discharge relations, Utah, Washington.

A technique was developed for characterizing water level fluctuations in irrigation canals using amplitude spectral estimates obtained with a fast Fourier transform. The technique, which is often used to analyze mechanical vibrations and electrical signals, is used with hourly water stage data to calculate dominant frequencies, amplitudes, and peaking times of water level fluctuations in eight irrigation canals in Utah and Washington. The results of this analysis indicate that water level fluctuations dominated by a daily cycle are statistically significant and that the time of peak water level occurred between 4 and 10 a.m. in all the canals studied. Amplitudes of water-level fluctuations in six of the eight canals that were unlined and unregulated are found to depend on canal (reach) length. Low frequency fluctuations with periods ranging from three to 10 days existed in the canals, but are statistically significant only in the spring and fall. Thus it maybe possible to control water-level fluctuations by scheduling water diversions into the canal from crop-water-use forecasts, especially during the summer and fall. (Author's abstract)
W90-08362

IRRIGATION PLANNING BY MULTILEVEL OPTIMIZATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
G. N. Paudyal, and A. Das Gupta.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 2, p 273-291, March/April 1990. 9 fig, 4 tab, 24 ref.

Descriptors: , *Irrigation design, *Irrigation engineering, *Multiobjective planning, *Optimization, *Water resources development, Algorithms, Computer programs, Crop production, Groundwater resources, Linear programming, Surface water availability, Water allocation, Water management, Water use efficiency.

The complex problem of irrigation management in a large heterogeneous basin is solved by using a multilevel optimization technique. The real problem consists of determining the optimal cropping patterns in various subareas of the basin, the optimal design capacities of irrigation facilities including both the surface and groundwater resources, and the optimal water allocation policies for the conjunctive use. The objective of such a management is to obtain a high level of economic efficiency in the irrigation development and water use system within a hydrologically feasible policy domain. Various alternative activities, such as surface water diversion and pumpage, groundwater withdrawal and recharge, and alternative future operational scenarios, have to be analyzed in an integrated way. The solution strategy is based on the physical decomposition of a large system into interconnected subsystems. A computationally efficient algorithm that can be implemented in a microcomputer is developed to solve the multilevel linear programming model by an iterative procedure. A case study illustrates the application in a realistic situation. (Author's abstract)
W90-08363

SIMPLE AND ACCURATE FRICTION LOSS EQUATION FOR PLASTIC PIPE.
Tennessee Univ., Knoxville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 8B.
W90-08364

PHYSIOLOGICAL RESPONSES OF TWO SOYBEAN (GLYCINE MAX (L.) MERR.) CULTIVARS TO SHORT-TERM FLOODING.
Arkansas Univ., Fayetteville. Dept. of Agronomy.
D. M. Oosterhuis, H. D. Scott, R. E. Hampton, and S. D. Wullschleger.
Environmental and Experimental Botany EEBODM, Vol. 30, No. 1, p 85-92, January 1990. 2 fig, 4 tab, 22 ref.

Descriptors: *Flooding, *Plant physiology, *Soybeans, *Water stress, Impervious soils, Leaves, Photosynthesis, Plant growth, Seeds, Soil types.

Flooding of soybean plants significantly reduces crop growth and yield, but the underlying physiological responses are poorly documented. The short-term physiological effects of flooding on soybean were studied in the field on a relatively impermeable soil classified as Type Albaqualf. Flooding treatments were imposed on two soybean cultivars, Essex and Forrest, at a vegetative (V4) and a reproductive (R2) growth stage. Diurnal measurements of net photosynthesis (P-n), stomatal conductance (g-s), and components of leaf water potential were recorded on 4 consecutive days following flood application, and again at 14 days after the flood was removed. Photosynthesis of Essex was reduced significantly within 48 h of flooding by 33 and 32% for the V4 and R2 growth stages, respectively, while reductions of 16 and 22% in P-n of Forrest were evident. Reductions in g-s of 46 and 24% occurred within 48 h for Essex and Forrest in the V4 stage, although in the R2 growth stage, both cultivars experienced an approximate 48% reduction in g-s. However, the decline in P-n with flooding was only partially explained by changes in g-s. Photosynthesis was correlated with stomatal closure at low g-s (<0.5 mol/sq m/s), but at higher values of g-s an approximate 20% reduction in P-n was observed presumably due to non-stomatal limitations. Flooding did not affect components of leaf water potential indicating that the decreases in P-n and g-s were not associated with plant water-deficit stress. Flooding of Essex and Forrest at either the V4 or R2 growth stage significantly reduced the dry matter accumulation during the flooding treatment and the subsequent growth. Final seed yields were reduced significantly by a mean of 52 and 40% for Essex and

Forrest, respectively. Overall, Forrest appeared more tolerant to excess water than Essex. (Author's abstract)
W90-08459

RESPONSE OF FOUR BRASSICA SPECIES TO DROUGHT STRESS.
Bahauddin Zakariya Univ., Multan (Pakistan). Inst. of Pure and Applied Biology.
For primary bibliographic entry see Field 2I.
W90-08460

SEMIARID SOIL AND WATER CONSERVATION.
CRC Press, Inc., Boca Raton, Florida. 1986. 126p. Edited by Herman J. Finkel.

Descriptors: *Semiarid lands, *Soil conservation, *Water conservation, Agriculture, Cultivation, Developing countries, Drought, Erosion control, Irrigation practices, Rainfall, Semiarid climates.

Semiarid regions have been defined in various ways. From the point of view of planning for soil and water conservation, definitions based upon long-term annual rainfall and temperature records are not sufficient. It is necessary to supplement them by a somewhat different approach. In the eastern part of the US and in much of Europe, precipitation is fairly well distributed throughout the year, either as rain or snow. In many tropical countries rainfall is also quite abundant during most months of the year. However, in some regions, the rainfall may be interrupted by a definite dry seasons for a period of time. The critical factor is not the total annual precipitation, which on the long-term average, may show values equal to or higher than the estimated potential evapotranspiration. It is, rather the length of the dry season which is important. This critical duration cannot be defined simply for all regions. It depends, partially, upon the antecedent precipitation, the storage capacity of the soil in the depth of the root zone, and the water requirements of the major crops. However, anything over 1 month of no precipitation during the normal growing season would justify classifying the region as semiarid. A major problem of controlling water erosion in semiarid regions arises from the lack of coincidence between the rainfall which causes the erosion, and the vegetative cover which protects the soil surface. This is particularly true of cultivated cropland and heavily grazed pastures, but somewhat less so for tree crops. In this volume, the erosion and conservation measures discussed are, for the most part, those under unirrigated agriculture. The use of irrigation could cause significant changes in the growing seasons, and in the agricultural calendar, especially in the warmer climates where temperature is not a limiting factor. Much of the material in this volume has been prepared with the developing countries of the so-called Third World in mind. In many of these countries there is a dearth of basic data, such as long-term hydrological records, detailed soil and topographic surveys, and experimental results for various types of erosion control measures. Some design procedures cannot be imitated or copied directly from those of the technologically more advanced countries. Consequently, emphasis will be placed, wherever possible, upon simple empirical methods of design, and approximate solutions within the limitations of the available data, technical possibilities, and financial resources of the Third World countries. (See W90-08533 thru W90-08541) (Lantz-PTT)
W90-08532

AGRONOMIC MEASURE FOR SOIL AND WATER CONSERVATION.
Finkel and Finkel, Yoqneam (Israel).
H. J. Finkel.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 39-53, 5 fig, 3 tab, 17 ref.

Descriptors: *Agronomy, *Land management, *Semiarid lands, *Soil conservation, *Soil erosion,

*Water conservation, Agriculture, Cultivation, Strip cropping, Tillage.

The first and most fundamental agronomic measure for soil conservation is correct land use. The rule is that no field should be used beyond its capability to sustain a stable and permanent soil profile. On the lands classified as suitable for cultivation of crops, much can be done for soil conservation by proper crop selection, rotation, and management. In the Mediterranean region the principal rain fed crop is winter grain, which may be grown either continuously, i.e., year after year, or in some rotation. One of the main factors to be considered is the intensity of the rotation, which refers to the number of times the land is tilled and planted to a crop in the period of the rotation. The permissible intensity is usually thought to be a function of the soil fertility as only the richer soils could support a program of continuous cropping. However, the recent trend has been to support continuous cropping by heavy application of fertilizers and to ignore rotation. After rotation, the next most important factor to consider from the point of view of erosion control, is tillage. Again, taking the Mediterranean region as an example, the principal rain fed crop which was grown on moisture accumulated from a previous winter fallow. When the wheat follows a summer crop the land will most probably be plowed either at the beginning of the summer or right after the first rains. There are advantages and disadvantages to either time of plowing, but in both cases the plowed land will be vulnerable to erosion when the stronger rains set in. Closely related to minimum tillage is the practice of mulching. This is simply the covering of bare soil with some material which prevents or reduces the evaporation of soil moisture, while inhibiting the growth of weeds. Mulching on sloping fields will considerably reduce the loss of soil from splash erosion by completely absorbing the energy of the impact. Research has demonstrated that cultivation of crops on the contour causes less erosion and conserves more water than cultivation up and down the slope. However, contour farming without strip cropping or terracing, has only a limited effect in reducing soil losses. It is most effective on slopes between 3 and 8%. On steeper slopes and for the more erodible soils, strip cropping is most effective. Typical widths for strip cropping range from 30 to 100 m. (See also W90-08532) (Lantz-PTT)
W90-08535

PASTURE AND FOREST MANAGEMENT IN THE MEDITERRANEAN UPLANDS.
Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering.
Z. Naveh.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 55-73, 3 fig, 56 ref.

Descriptors: *Conservation, *Forest management, *Literature review, *Mediterranean Sea, *Pasture management, *Semiarid lands, Agriculture, Ecosystems, Soil conservation, Water conservation.

There is probably no other region in the world that has endured more long lasting and intensive human impact throughout its history than the Mediterranean Basin. There is also no other region where the unfortunate combination of a vulnerable environment and a long history of man's misuse of the land have caused such far-reaching and severe damage of soil erosion and depletion, landscape desiccation, and what is called now 'desertification'. Nowhere else are the dangers of combined traditional and neotechnological pressures from accelerating populations, tourists, and urban-industrial developments more threatening, causing new menaces of soil and water erosion, flooding, and land destruction. At the same time, however, because of these long lasting and severe human pressures, nowhere else—at least in comparable climatic and ecological conditions—can the striking resilience, regenerative powers, and soil building the protective capacities of the native vegetation be demonstrated better than on the denuded Mediterranean uplands. This chapter is a literature review which attempts to point out these features and to show that they can be used as part of conservative,

ecologically sound management and improvement practices for the redemption of these uplands, not only for pastoral and silvilcultural uses, but also for other multiple, socioeconomic and ecological benefits, and above all, for upland soil and water conservation. (See also W90-08532) (Lantz-PTT)
W90-08536

ENGINEERING MEASURES: WATERWAYS AND DIVERSION CHANNELS.
Finkel and Finkel, Yoqneam (Israel).
H. J. Finkel.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 75-84, 7 fig, 1 tab, 4 ref.

Descriptors: *Diversion channels, *Hydraulic structures, *Semiarid lands, *Soil conservation, *Water conservation, *Waterways, Agronomy, Erosion control, Flow velocity, Grassed waterways.

There is a certain logical order in applying soil and water conservation measures to cultivated fields, proceeding from the simple and less expensive to the more complex and expensive. Only where the lesser measures are inadequate are the greater measures added. A full program begins with correct land use, proceeds to selection of allowable intensity of rotation, and is followed by contour farming, with strip cropping where needed. All of these measures are within the farmer's ability to establish alone, with the advice of a competent farm planner and a bit of technical help. If all of these practices are not sufficient, the farmer must turn to the engineering measures which require a somewhat higher level of technical assistance, and are more costly. The first engineering measure to be established is the protected, or permanent, waterway. This is in effect, both an agronomic and an engineering measure. A field of rolling topography can naturally be divided into ridges and depressions. The depressions, or draws, form natural outlets or waterways for the disposal of runoff. If they are spaced too closely, not all of them need be used, and only some may be selected for conversion into waterways. A reasonable spacing of the waterways is from about 75 to 200 m, depending upon the slope of the land and the general unevenness of the topography. A diversion ditch is a channel that is generally built across the slope to divert surface flow from its natural course to another outlet. Diversion ditches may serve the following purposes: (1) Where a cultivated field of moderate slope lies at the foot of a steeper slope or hill which is not cultivated, the first soil conservation measure is to isolate the field to be treated from the larger watershed lying above it; (2) In the case of a deep gully which is being eroded 'headward' by an overfall at its upper end, a diversion ditch may be built around the eroding gully head before other control measures are attempted; (3) If a spring or other form of groundwater breaks out at the surface of a sloping field, it may be captured and led off to a prepared outlet by means of a diversion ditch; and (4) The diversion ditch may be used to safely carry away a discharge of water from some source point. (See also W90-08532) (Lantz-PTT)
W90-08537

ENGINEERING MEASURES FOR SOIL AND WATER CONSERVATION TERRACING AND BENCHING.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 4D.
W90-08538

ENGINEERING MEASURES: WATER HARVESTING.
Finkel and Finkel, Yoqneam (Israel).
H. J. Finkel, and M. Finkel.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 93-101, 2 fig, 7 ref.

Descriptors: *Semiarid lands, *Water conservation, *Water harvesting, *Water resources development, Dams, Diversion, Runoff, Semiarid climates, Water storage.

Water harvesting is the collection of runoff and its use for the irrigation of crops, pastures, and trees, and for domestic and livestock consumption. Since this definition could cover almost all fields of water resource development, it must be added that the term 'water harvesting' is usually used for the development of marginal waters in arid or semiarid regions. The projects are generally local and of a small scale that do not include the treatment of water or its conveyance over long distances. They must be classified according to the source of water and the use to which it will be put. The latter has two categories: irrigation and for human and/or animal consumption. The case of water for consumption, two additional elements must be included: storage and treatment. The storage is needed because the rate of consumption of water will generally be slower than the rate of harvesting. In the case of water for irrigation, the soil itself serves as a reservoir for a certain period of time. For a longer storage period seasonal reservoirs may be required. Dams on intermittent streams to contain flash floods are also considered to be a form of water harvesting. (See also W90-08532) (Lantz-PTT)
W90-08539

GULLY CONTROL.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 4D.
W90-08540

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

ERIE AND CAMPBELL LAKES. FINAL REPORT: RESTORATION IMPLEMENTATION AND EVALUATION.
Entranco Engineers, Inc., Kirkland, WA.
For primary bibliographic entry see Field 5G.
W90-07508

URBAN SURFACE WATER MANAGEMENT.
Valparaiso Univ., IN.
S. G. Walesh.
John Wiley and Sons, Inc., New York, New York. 1989. 518p.

Descriptors: *Computer models, *Hydraulic structures, *Planning, *Surface water, *Urban hydrology, *Water management, Design standards, Erosion control, Flood control, Hydraulic engineering, Nonpoint pollution sources, Nonstructural alternatives, Sedimentation, Storm runoff, Storm wastewater, Water storage.

State-of-the-art engineering tools and techniques have been and can be used to manage the quantity and quality of urban stormwater runoff. This book's focus is on planning and designing facilities and systems to prevent or to control flooding, erosion, sedimentation, and nonpoint source pollution. Subject matter in the book is arranged to flow from fundamentals through engineering analysis and design methodologies, concluding with application and integration. Chapter 1, 'Fundamentals of Urban Surface Water Management,' and Chapter 2, 'The Hydrologic Cycle in the Urban Environment,' focus on fundamentals. Chapters 3 through 7 present many and varied engineering analysis and design methodologies. The range and depth of topics covered in this middle portion of the book is suggested by the titles of Chapters 3 through 7, which are, respectively: 'Techniques for Hydrologic Analyses,' 'Floodplain Hydraulics,' 'Stormwater Facility Hydraulics,' 'Computation of Average Annual Monetary Flood Damage,' and 'Nonpoint Source Pollution Load Techniques.' Beginning with Chapter 8 and extending through Chapter 12, the last chapter, application and synthesis are emphasized. Technical material presented in earlier chapters is utilized and nontechnical

and other considerations are introduced. The planning and design of detention/retention facilities and of sedimentation basins are covered, in Chapters 8 and 9. Chapter 10 provides a comprehensive and in-depth treatment of modeling in urban surface water management, with emphasis on computer modeling as being a practical and often the only way to utilize fully the technology available in urban surface water management. Chapter 11 provides a comprehensive summary of structural and nonstructural measures available for managing the quantity and quality of urban surface water. Chapter 12, presents a process for preparing urban surface water master plans that are intended to be implemented. (Lantz-PTT)
W90-07551

INCORPORATING DAILY FLOOD CONTROL OBJECTIVES INTO A MONTHLY STOCHASTIC DYNAMIC PROGRAMING MODEL FOR A HYDROELECTRIC COMPLEX.
British Columbia Hydro and Power Authority, Vancouver. System Operations and Maintenance Div.
For primary bibliographic entry see Field 7C.
W90-07634

REAL-TIME CONTROL OF A SYSTEM OF LARGE HYDROPOWER RESERVOIRS.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W90-07672

EFFECTS OF HEDGING ON RESERVOIR PERFORMANCE.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
M. Bayazit, and N. E. Unal.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 713-719, April 1990. 11 fig, 4 ref.

Descriptors: *Reservoir operation, *Reservoir releases, Hedging, Performance stability, Water deficit, Water supply reservoir.

The effects of operating a water supply reservoir with a policy of hedging on various reservoir performance criteria were investigated. The results of simulations where policies with different degrees of hedging are adopted were used to determine how reliability, resiliency, and mean and maximum deficit vary as functions of hedging parameters and to derive the relationships between these criteria. It was found that the standard operating policy was the best in relation to reliability and resiliency and was satisfactory with regard to deficits. Hedging improved the performance with respect to mean deficit if it was started with sufficient water in storage. If hedging was applied when there was little water in storage, it reduced the risk of very large future deficits, although the mean deficit is increased. If hedging was continued even when the demand could be supplied, the performance of the reservoir is more stable and the mean deficit is decreased, but these are achieved at a cost of increasing the rate of failure. (Author's abstract)
W90-07679

EVALUATION OF FACTORS AFFECTING RESERVOIR YIELD ESTIMATES.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
R. A. Wurbs, and C. E. Bergman.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/4, p 219-235, January 1990. 1 fig, 4 tab, 19 ref.

Descriptors: *Computer models, *Model studies, *Reservoir operation, *Reservoir yield, *Water yield improvement, Data interpretation, Simulation analysis, Water supply.

Estimates of yield versus reliability relationships and firm yield are fundamental to water supply planning and management. Simulation models are commonly used for reservoir yield studies. Numerous generalized computer programs are readily available for such studies, including the HEC-3,

HEC-5, MOSS-IV, and TAMUWRAP models. An evaluation of key practical aspects of analyzing reservoir system yield from the perspective of a case study is presented. The various factors affecting reservoir yield estimates can be classified as involving: (1) compilation and development of basic data representing basin hydrology; (2) simulation of the physical characteristics and operating policies of the reservoir system; and (3) modeling the impacts of basin-wide water management and use and other related activities on the reservoir system of concern. The stochastic nature of streamflow and evaporation, changes in a river basin over time, loss of reservoir storage capacity due to sedimentation, reservoir system operating policies, and interactions between multiple water users are particularly important fundamental aspects of a water supply and use system which must be considered in yield studies. An entire river basin should be viewed as an integrated system in analyzing the amount of water which can be provided under various conditions. (White-Reimer-PTT)
W90-07723

SALINITY CHANGES IN CHARLESTON HARBOR 1922-1987.
South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.
For primary bibliographic entry see Field 2L.
W90-07733

EVALUATION OF SOME METHODS OF DETERMINING STORAGE YIELD RELATIONSHIPS FOR IMPOUNDING RESERVOIRS.
Hanley (Ryan) and Co., Galway (Ireland).
For primary bibliographic entry see Field 6B.
W90-07931

FLOOD FREQUENCY ANALYSIS FOR THE 1988 TRURO FLOODS.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W90-07934

FLOOD-PREVENTION SCHEME OF VENICE: EXPERIMENTAL MODULE.
J. Lewin, and A. Scotti.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 70-77, February 1990. 8 fig, 14 ref.

Descriptors: *Flood control, *Flood protection, *Floodgates, *Venice, Caissons, Historic floods, Hydraulic gates.

Records exist of the flooding of Venice from the days of the Republic. During the last century flooding incidents have become more severe due to subsidence of the city and rising water levels in the Adriatic. Calamitous flooding occurred in 1966, and two devastating floods were experienced during the last decade. This resulted in the design of three movable barrages to seal off the Venice lagoon in the event of a flood. The construction of a full-size gate and caisson (the prototype of the eighty gates forming the barrages) was subsequently authorized. The initial tests of the experimental module (MOSE) were successful. The raising and lowering of the prototype gate was much more damped than the model studies had indicated, and it is possible that the added mass of the gate is greater than the assumed value. The gate has been detached and connected a number of times without any difficulties being experienced. The hydraulic ejector system for the removal of sediment and bed material from the caisson was effective over a wide range of particle size--up to stones of 50-70 mm. At the design stage it was considered that it was not possible to control the rate of lowering of the gate, and operation of MOSE has demonstrated that some control can be effected by operating the air-release valves. (Brunone-PTT)
W90-07935

RIVER BASIN MANAGEMENT: DEVELOPING THE TOOLS.
Water Research Centre, Swindon (England).
Swindon Engineering Centre.

For primary bibliographic entry see Field 5G.
W90-07937

RETHINKING FLOOD-CONTROL CHANNEL DESIGN.
Williams (Philip) and Associates, San Francisco, CA.
P. B. Williams.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 4, p 57-59, 1989.

Descriptors: *Channel flow, *Design criteria, *Flood channels, *Flood control, *Flow resistance, Channel morphology, Channel scour, Maintenance, Roughness coefficient, Sediment transport, Vegetation effects.

The flooding of the Corte Madera Creek flood-control channel in Marin County, California in 1982 illustrates the problems of traditional flood-control design using channelization. Problems arise when the effects of sediment and siltation are overlooked in designing flood channels. Flow resistance is often underestimated when the selection of the Manning hydraulic roughness is a matter of engineering judgment rather than a decision based on actual flood-channel performance. Bed forms and sediment transport may have more of an effect on flow resistance than bank vegetation. During large floods appreciable amounts of bed load may be transported significantly increasing the composite channel roughness, causing the supercritical flow to shift back to deeper slower-moving subcritical flows leading to over-bank flooding. Large floods can also generate debris which can catch on bridge pilings and substantially increase flood elevations. Where streams flow in alluvium, erosion and sediment accumulation can affect flood risk. Maintenance procedures may actually increase flood risks in some areas. Riparian vegetation when left intact may actually shade out the channel, increasing its flow capacity. A new approach to flood-control channel design considers flood-hazard reduction as one component of a multiobjective riparian corridor management strategy. The successful development of a multiobjective design requires an understanding of the complex physical behavior of natural streams and how they interact with the ecosystem. A synthesis of hydraulic engineering and fluvial geomorphology is needed which would encourage designers to work with natural processes rather than combat them. The resulting design would anticipate sediment movement, stream meandering and bank erosion. The two-stage flow-channel concept calls for the construction of an artificial flood-plain terrace and the excavation of a low-flow channel (sized to the equilibrium bank full flood). The terrace provides space for a walking trail, and the low-flow channel allows fish and sediment to move downstream. Planting riparian trees on the bank shades out the channel, which prevents vegetation encroachment, minimizes maintenance and erosion, improves water quality and creates a continuous corridor for wildlife. A program for monitoring actual flood flows and elevations can assist in deciding where and whether channel capacity needs to be increased, bridges replaced or floodwalls constructed. (Geiger-PTT)
W90-07960

GEOTEXTILES AND DRAINAGE.
New York State Dept. of Transportation, Albany.
For primary bibliographic entry see Field 8G.
W90-08128

LATERAL DRAINAGE DESIGNS USING GEOTEXTILES AND GEOCOMPOSITES.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8G.
W90-08129

STORMWATER DETENTION FOR DRAINAGE, WATER QUALITY, AND CSO MANAGEMENT.
Malmo Water and Sewer Works (Sweden).
For primary bibliographic entry see Field 5G.

Group 4A—Control Of Water On The Surface

W90-08138

OVERCOMING FEDERAL WATER POLICIES.
California State Dept. of Water Resources, Sacramento. Financial Assistance and Environmental Review Branch.
For primary bibliographic entry see Field 6E.
W90-08289

LAND-GRADING DESIGN BY USING NON-LINEAR PROGRAMMING.
Baghdad Univ. (Iraq). Coll. of Engineering.
For primary bibliographic entry see Field 3F.
W90-08359

4B. Groundwater Management

WATER DEVELOPMENT FOR PHOSPHATE MINING IN A KARST SETTING IN FLORIDA-- A COMPLEX ENVIRONMENTAL PROBLEM.
La Moreaux (P.E.) and Associates, Inc., Tuscaloosa, AL.
For primary bibliographic entry see Field 6G.
W90-07658

REDUCTIONIST PHYSICAL APPROACH TO UNSATURATED AQUIFER RECHARGE FROM A CIRCULAR SPREADING BASIN.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-07684

FLOW PATTERN IN REGIONAL AQUIFERS AND FLOW RELATIONS BETWEEN THE LOWER COLORADO RIVER VALLEY AND REGIONAL AQUIFERS IN SIX COUNTIES OF SOUTHEASTERN TEXAS.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-07852

UNDERGROUND COAL MINES AS SOURCES OF WATER FOR PUBLIC SUPPLY IN NORTH-ERN UPSHUR COUNTY, WEST VIRGINIA.
Geological Survey, Charleston, WV. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-07853

GEOHYDROLOGY AND GROUND-WATER QUALITY AT SELECTED SITES IN MEADE COUNTY, KENTUCKY, 1987-88.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-07854

HANDBOOK OF GROUND WATER DEVELOPMENT.
Moss (Roscoe) Co., Los Angeles, CA.
John Wiley and Sons, New York, New York. 1990. 493p.

Descriptors: *Groundwater management, *Groundwater mining, *Water resources development, *Wells, Aquifers, Artificial recharge, Drilling, Geohydrology, Groundwater availability, Groundwater budget, Groundwater movement, Groundwater potential, Groundwater recharge, Pumping, Well construction.

Designed for practical engineers, hydrologists, mining geologists, and anyone involved in the development of groundwater, this book provides an overview on the subject of groundwater development. The text is divided into three parts: Part I deals primarily with the nature of groundwater and where it can be found; Part II considers the parameters related to water well design and construction; and Part III covers well and well field operation. Although the emphasis is on high-capacity groundwater producing installations, most

of the material applies to lower-yield wells. Chapter titles are: geologic formations as aquifers; movement of groundwater; exploration for groundwater; geophysical borehole logging; hydraulics of wells; well design--general considerations; drilling systems; drilling fluid; stresses on well casing and screen; corrosion and incrustation; selection of casing and screen; water well cementing; formation stabilizer and filter pack; well development; well and aquifer evaluation from pumping tests; vertical turbine pumps; well and pump operation and maintenance; groundwater quality and contamination; artificial recharge; and groundwater management. Appendices provide information on sources of geohydrological information and data, geographic groundwater regions in the U.S., estimating the value of parameters of the hydrologic budget, properties and standards for water well casing and groundwater models. (Lantz-PTT)
W90-08140

HIGH PLAINS REGIONAL AQUIFER--ESTIMATING 1980 GROUND-WATER PUMPAGE FOR IRRIGATION.
Geological Survey, Menlo Park, CA.
F. J. Heimes.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Presented at 24th Annual AWRA Conference and Symposium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 207-218, 3 fig, 4 tab, 6 ref.

Descriptors: *Data acquisition, *Groundwater budget, *Groundwater irrigation, *Groundwater management, *High Plains Regional Aquifer, *Regional Aquifer Systems Analysis, Groundwater mining, Groundwater use, Irrigation practices, South Dakota, Surveys, Texas, Water use.

In order to obtain information about current trends in groundwater use for irrigation for the High Plains Regional Aquifer System Analysis, an approach based on field sampling was used to estimate groundwater pumped for irrigation throughout the High Plains during the 1980 growing season. The volume of groundwater pumped for irrigation was computed by combining sampled water-application measurements with mapped irrigated-acreage information. Irrigation application (inches of water applied) was measured at 480 sites in 15 counties in the High Plains during the 1980 growing season. Relationships between irrigation demand, calculated using the Blaney-Criddle consumptive-use formula, and measured application were used to estimate application for unsampled areas of the High Plains. The estimated application was calculated for each 1-degree latitude by 1-degree longitude area in the High Plains. Application estimates multiplied by irrigated-acreage estimates, derived from analysis of Landsat-satellite imagery, yielded the volume of groundwater pumped for irrigation. Estimates of water pumped for irrigation during 1980 were aggregated by State and as a total estimate for the entire High Plains. The estimate of water pumped for irrigation in the High Plains during 1980 was 17,980,000 acre-ft applied to 13,700,000 acres. Texas had the most dense irrigation development in the High Plains, whereas South Dakota was virtually undeveloped. The application data derived from sampling were evaluated for significant trends. The data indicated a greater application for such crops as corn and hay and a lesser application for such crops as sorghum, grain, and cotton. The data also indicated greater pumpage for flood-irrigation systems than for sprinkler-irrigation systems. Areas of the High Plains with thin saturated thickness tended to have a smaller average discharge per well, fewer irrigated acres per well, and a predominance of crops requiring less water. (See also W90-08400) (Author's abstract)
W90-08411

HIGH PLAINS REGIONAL AQUIFER--MAPPING IRRIGATED AGRICULTURE USING LANDSAT DATA.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 7C.
W90-08412

MANAGEMENT OF SLOW SAND FILTERS IN RESPECT TO GROUND WATER QUALITY.
Institut fuer Wasserforschung, Schwerte (Germany, F.R.).
For primary bibliographic entry see Field 5F.
W90-08475

DEVELOPMENT OF A SLOW SAND FILTER MODEL AS A BIOASSAY.
Institut fuer Wasserforschung, Dortmund (Germany, F.R.).
C. Schmidt.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 191-205. 13 fig, 2 tab, 2 ref.

Descriptors: *Artificial recharge, *Bioassay, *Computer models, *Filtration, *Model studies, *Sand filters, *Slow sand filtration, Algae, Groundwater recharge, Microorganisms, Water quality, Water treatment.

Due to the difficulty of describing the actual biological reactions during artificial groundwater recharge, computer aided slow sand filter models were developed at a laboratory scale to simulate the biological, chemical and physical conditions of a real filter. Modern fermenter technology (cultures of algae and microorganisms) in connection with the filter models can improve the knowledge of the limits of biological water purification, the behavior of pollutants during the filtration process, the hazardous effects on filter organisms due to a high pollution load, and the toxic or subtoxic effects of water components on a biological system (system-bioassay). In the filter model a stabilization of biological and chemical parameters was established after a certain time. These conditions were similar to the conditions in a natural filter. The filter model system did not oscillate in an uncontrollable way; it followed the input parameters after a period of equilibrium establishment. (See also W90-08470) (Geiger-PTT)
W90-08482

KARST HYDROLOGY: CONCEPTS FROM THE MAMMOTH CAVE AREA.
For primary bibliographic entry see Field 2F.
W90-08542

IMPACTS OF RIVER TRAINING ON THE QUALITY OF BANK-FILTERED WATERS.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 6G.
W90-08627

4C. Effects On Water Of Man's Non-Water Activities

URBAN SURFACE WATER MANAGEMENT.
Valparaiso Univ., IN.
For primary bibliographic entry see Field 4A.
W90-07551

HYDROLOGIC RESPONSES OF COMPACTED FOREST SOILS.
Southern Illinois Univ. at Carbondale. Dept. of Plant and Soil Sciences.
For primary bibliographic entry see Field 2G.
W90-07729

EFFECTS OF LIMESTONE QUARRYING AND CEMENT-PLANT OPERATIONS ON RUNOFF AND SEDIMENT YIELDS IN THE UPPER PERMANENTE CREEK BASIN, SANTA CLARA COUNTY, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
K. M. Nolan, and B. R. Hill.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4130,

1989. 48p, 11 fig, 19 tab, 40 ref.

Descriptors: *California, *Industrial plants, *Mine wastes, *Quarries, *Sediment transport, *Sediment yield, *Water pollution sources, Accelerated erosion, Santa Cruz Mountains, Storm runoff, Subsurface runoff, Watershed management.

High sediment loads below headwater areas of the Permanente Creek drainage basin, Santa Clara County, California, have caused flood-control problems in downstream lowland areas. Measured sediment yields in Permanente Creek, which drains areas affected by limestone quarrying and cement-plant operations, were 14 times greater than yields from the West Fork Permanente Creek, which primarily drains parkland. Part of this large disparity in yields is the result of higher runoff/unit of drainage area in the Permanente Creek Basin. Results of rainfall-runoff modeling indicate that the tendency for higher runoff from Permanente Creek results from natural differences in basin physiography. Runoff during periods of high streamflow (when most sediment is transported) is dominated by subsurface flow, which is not affected by human activities. Although artificial features created by human activities seem to have had only minor effects on runoff, they apparently have had major effects on sediment availability. Artificial features accounted for 273 acres (89%) of the 307 acres of active erosional landforms mapped in 1984. Increased availability of sediment in the Permanente Creek basin appears to be indicated by elevated intercepts of sediment-transport curves. A comparison of sediment-transport curves for the West Fork Permanente Creek with similar curves for the Permanente Creek basin under natural conditions suggests that the sediment yield from Permanente Creek is about 3.5 times higher than it would be under natural basin conditions. The increased yield apparently is due to an increase in sediment availability rather than an increase in runoff. (USGS)
W90-07841

SUMMARY OF DATA PERTAINING TO LAND USE, RAINFALL, DRYFALL, STREAM DISCHARGE, AND STORM RUNOFF COLLECTED AS PART OF A STUDY OF THE EFFECTS OF URBAN RUNOFF ON RAPID CREEK, RAPID CITY AREA, SOUTH DAKOTA.
Geological Survey, Rapid City, SD. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-07862

ENVIRONMENTAL ASSESSMENT OF THE SUNSET AND BIG DESERT LANDS, NORTH-WEST VICTORIA.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia).
B. R. Tunstall, and P. H. Reece.
Divisional Report 89/2, July 1989. 85p, 50 fig, 2 tab, 2 append, 5 maps.

Descriptors: *Australia, *Environmental policy, *Land use, *Military reservations, Deserts, Soil stability, Vegetation.

Environmental guidelines are provided to aid the planning and conduct of military exercises in the Sunset and Big Desert Lands of north-west Victoria to minimize environmental damage without imposing undue constraints on exercises. An evaluation of the natural resources of the area is given using the Land Systems approach. The patterns of Land Units within Land Systems are defined and the Land Systems mapped. Other maps give the locations of remnant beach ridges, land use zones as defined by the Victorian Government, age of post-fire vegetation regeneration and trafficability. The geology and climate of the area are discussed with particular reference to temperature regimes, rainfall probabilities and the seasonal hazard of wind driven dust. Vehicular traffic has little impact on dry clay soils but causes compaction when conditions are wet. Saline soils usually become rutted because of the continuously high soil moisture content below the surface. The displacement of the surface of sandy soils vehicles is minimal with a single pass on moist soils and maximal with

multiple vehicle passes on dry soils. Large areas of sand should not be disturbed because of the possibility of subsequent erosion of the soil by wind, particularly on the upper slopes and crests of dunes. The main effect of exercises on vegetation is damage to the aerial portions of plants by vehicles and pedestrians. Roots of the plants may also be damaged, particularly where the impact is severe. These impacts are obvious because only small areas are affected and the adjacent undisturbed vegetation provides a basis for comparison. The response of vegetation following crushing and/or unearthing can currently only be inferred from observations of the changes in vegetation following fire and clearing for agriculture; burning can be regarded as equivalent to crushing vegetation and clearing and ploughing equivalent to unearthment. However, both burning and clearing for agricultural purposes have a greater effect than the equivalent military activity because of the much greater area affected and the higher frequency of impact. Recommendations include: conduct exercises from late February to early May; areas shouldn't be reused within two years; and tracked vehicles should not track when off road nor traverse high dunes, salt pans or wet clay soils. (Lantz-PTT)
W90-08163

ESTIMATING UNCERTAINTY OF STORM-WATER RUNOFF COMPUTATIONS.
Texas Univ. at Dallas, Richardson. Inst. for Environmental Sciences.
J. J. Warwick, and J. S. Wilson.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 187-204, March/April 1990. 7 fig, 3 tab, 24 ref.

Descriptors: *Data interpretation, *Model studies, *Storm runoff, *Storm water management, *Urban hydrology, Accumulation, Dallas, Runoff, STORM program, Tulsa.

The stormwater runoff quantity component of the U. S. Army Corps of Engineers storage, treatment, overflow and runoff model (STORM) program has been successfully calibrated and verified for a residential community located in Dallas, Texas. Limited water quality data preclude application of typical statistical testing of model runoff quality predictive capabilities. A Monte Carlo simulation technique was therefore employed to ascertain probable ranges of STORM water quality predictions in light of both water quantity and quality input parameter uncertainties. The resulting 95% occurrence intervals of probable model runs were compared with a limited water quality data set to test model adequacy. An original modelling scenario, utilizing suggested areal accumulation rates derived from a study conducted in Seattle, Washington, was rejected because the measured total suspended solids concentrations were far above the upper bound of the computed 95% occurrence interval. A second modelling scenario using areal accumulation rates obtained from Tulsa, Oklahoma, cannot be rejected based upon the comparison of measured data and the computed 95% occurrence intervals. (Author's abstract)
W90-08274

RISK-COST DESIGN OF PAVEMENT DRAINAGE SYSTEMS.
GKY and Associates, Inc., Springfield, VA.
G. K. Young, and S. E. Walker.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 205-219, March/April 1990. 5 fig, 5 tab, 14 ref, append.
DOT Federal Highway Administration Contract DTFH61-84C-00082.

Descriptors: *Design criteria, *Drainage systems, *Risk assessment, *Urban hydrology, Case studies, Hyetographs, Roads.

A practical method for determining the road surface drainage system design with the theoretical lowest total economic cost (LTEC) was developed. The LTEC method determined the design rain which, when used in a rational-based design context, will yield the most economic choices of gutters, inlets and laterals considering both construction costs and risk costs. The method provides

an alternative to the use of fixed return period design criteria. Daily rainfall served as the random variable used in performing the risk analysis. The right-hand tail of the probability density function for daily rainfall was approximated with a normal curve. A triangular hyetograph of average duration was assumed to be appropriate for representing an individual rainstorm. A nomograph and data selection guide were provided as design aids. Case studies were presented in an appendix. The method, based on minimizing traffic delay costs, applies to freeways, arterials and major collectors; local streets with low traffic may be excluded. (Author's abstract)
W90-08275

IMPACT OF DIFFUSE NITRATE POLLUTION SOURCES ON GROUNDWATER QUALITY--SOME EXAMPLES FROM CZECHOSLOVA-KIA.
Stavebni Geologie, Prague (Czechoslovakia). Hydrogeology Dept.
V. Benes, V. Pekny, J. Skorepa, and J. Vrba.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 5-24, November 1989. 15 fig, 5 tab, 18 ref.

Descriptors: *Agricultural runoff, *Groundwater pollution, *Groundwater quality, *Nitrates, *Nonpoint pollution sources, *Path of pollutants, Aquifers, Czechoslovakia, Farm wastes, Fertilizers, Model studies.

A program of research into the effects of farming activities on groundwater quality in Czechoslovakia is under way on experimental fields (20 to 30 hectares) and, simultaneously, in regions in which shallow, vulnerable aquifers occur. The importance of the soil organic matter's stability for maintaining the groundwater quality is emphasized. Research based on nitrogen and organic carbon balance has shown that restoration of a soil-groundwater system is a complicated process, usually requiring changes in the extent and intensity of agricultural activities and consistent attention to the effects produced by natural conditions. The WASTEN deterministic model was used for modeling the transport and transformation of various types of inorganic fertilizers. The input data is based on laboratory and field measurements. The model has shown that the processes which occur in the unsaturated zone strongly control the amount of nitrogen leached into the saturated zone. The regional-scale increase in nitrate contents in shallow aquifers located in the fluvial deposits of the Elbe River, central Bohemia, are decisively affected by farming activities, particularly the high doses of inorganic fertilizer applied. During the past 30 years, nitrate contents in groundwater under cultivated arable land have doubled, as have cereal yields, while the amount of fertilizer applied has grown nearly 8-fold. Short-term cyclic changes in nitrate content have been identified in the aquifer's upper parts, depending mainly on climatic conditions. The fast response by the shallow aquifer's system to extreme climatic situations is particularly emphasized. The long-term changes and the increasing trend in nitrate concentrations in groundwater reflect anthropogenic, especially farming, influences. (Author's abstract)
W90-08295

CHANGES IN BIOLOGICALLY CONTROLLED CARBON FLUXES IN A SMALL STREAM FOLLOWING CONTINUOUS SUPPLY OF EXCESS ORGANIC LOAD.
Universite de Savoie, Chambery (France). Lab. d'Ecologie.
For primary bibliographic entry see Field 5B.
W90-08307

LONGITUDINAL STRUCTURE OF AN AGRICULTURAL PRAIRIE RIVER SYSTEM AND ITS RELATIONSHIP TO CURRENT STREAM ECOSYSTEM THEORY.
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 2H.
W90-08437

Group 4C—Effects On Water Of Man's Non-Water Activities

MOVEMENTS OF CHANNEL AND FLAT-LAND CATFISH BETWEEN THE MISSOURI RIVER AND A TRIBUTARY, PERCHE CREEK.
Missouri Univ.-Columbia. School of Forestry, Fisheries and Wildlife.
H. R. Dames, T. G. Coon, and J. W. Robinson.
Transactions of the American Fisheries Society TAFSAI, Vol. 118, No. 6, p 670-679, November 1989. 5 fig, 5 tab, 32 ref.

Descriptors: *Backwater, *Catfish, *Fish migration, *Fish populations, *Rivers, *Tributaries, Missouri River, Perche Creek.

Most backwater habitats in the lower Missouri River have been eliminated by human modifications for navigation and flood control, and fish populations have declined in response. Since the 1940s, the river has become virtually devoid of backwater lakes and side channels. The lower segments of tributary streams provide the only remaining backwater habitat for much of the lower Missouri River. This study describes the movements of adult channel catfish Ictalurus punctatus between 13-km segment of the Missouri River and a tributary, Perche Creek, that enters the river in this segment to determine the extent to which a river-dwelling fish use the tributary habitats. Mark-recapture techniques were used to describe movements of fish larger than 250 mm in total length between these habitats during a 22-month period. Most fish (59%) initially caught, recaptured, or both in the Missouri River moved into or out of Perche Creek, and most of these transient fish (72%) used the lower 8 km of the tributary. The tributary population was made up predominantly of resident fish (79%), which were initially caught and recaptured in Perche Creek. Channel catfish moved greater distances in the spring than in the fall and were more likely to move upstream in the spring and downstream in the fall. Fish shorter than 250 mm were more abundant in the river than in the creek and made up 45 and 35% of the catches in each area, respectively. Of the fish longer than 280 mm, a greater proportion of the fish resident in the river (44%) than in the creek (33%) were longer than 380 mm. More fish longer than 380 mm moved from the creek to the river (44%) than from the river to the creek (26%). Thus, the tributary habitat was used most frequently by fish 280-380 mm long. Flathead catfish Pylodictis olivaris were much less abundant in the creek than in the river and did not provide sufficient sample sizes to evaluate movement patterns. However, based on abundances in the catches, the proportion of river flathead catfish using the creek was much lower than for channel catfish. Most of the few flathead found in the creek were longer than 280 mm. (Author's abstract)
W90-08467

IMPACT OF THE CHERNOBYL ACCIDENT ON THE RADIOACTIVITY OF THE RIVER DANUBE.
Novi Sad Univ. (Yugoslavia). Inst. of Physics.
For primary bibliographic entry see Field 5B.
W90-08631

URBAN DEVELOPMENT IN THE DANUBIAN BASIN AND ITS EFFECTS ON WATER QUALITY–ASPECTS AND TRENDS.
Executive Council of the Socialist Republic of Serbia, Belgrade (Yugoslavia).
R. Vujnovic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 281-286, 1990. 5 tab, 7 ref.

Descriptors: *Danube River Basin, *Planning, *Regional planning, *Urbanization, *Water pollution effects, *Water resources management, Rivers, Urban planning, Water pollution sources, Water quality standards.

The fate and future of urbanization in the Danube Basin is linked to the processes of urban agglomerations in Europe and it can be expected that increased urban concentrations will develop along the Danube and its main tributaries, just as other regional urban systems develop in Europe. The natural potential of the Danube Basin is limited from the point of view of future agglomerations.

The main limitations come from the availability of natural water resources, and further, from the limited spaces for specific uses. The deterioration of water quality by pollution may additionally restrict the limits of urbanization; improvement or deterioration of the situation would depend on the location and character of the sources of pollution. The idea that urban development in the Danube Basin must be jointly planned by all Danube countries (in the form of a water master plan or a physical plan of the basin) is becoming increasingly appreciated. The general objective of the plans would be to make the best use of the Danube and tributaries, for the benefit of the people living in the basin. (Author's abstract)
W90-08643

4D. Watershed Protection

HYDE PARK LAKE RESTORATION PROJECT, NIAGARA FALLS, NEW YORK.
New York State Dept. of Environmental Conservation, Albany.
For primary bibliographic entry see Field 5G.
W90-07509

GEOTEXTILES AS FILTERS IN EROSION CONTROL.
Chemie Linz U.S., Incl, Golden, CO 80401.
R. K. Frobel, G. Werner, and M. Wewerka.
IN: Geotextile Testing and the Design Engineer. ASTM Special Technical Publication 952, 1987. American Society for Testing and Materials, Philadelphia, PA. p 45-54, 7 fig, 9 ref.

Descriptors: *Bank protection, *Erosion control, *Filters, *Geotextiles, *Materials testing, Design criteria, Filtration, Geosynthetic materials, Porosity.

Geotextiles are often used in place of conventional mineral filters in erosion control applications along lake or ocean shorelines, canals, stream channels, and other hydraulic structures. The geotextile can effectively replace the aggregate filter system or replace one of the layers in a multilayer filter system. A geotextile in combination with aggregate riprap or gravel can also be used to reduce surface erosion due to internal embankment piping or surface runoff. In considering the use of a geotextile to replace a conventional granular filter, the design engineer must evaluate the various kinds of fabrics available and the filtration behavior associated with the type of fabric structure. Mechanically needle-punched nonwoven geotextiles form a three-dimensional structure of fibers. It is this feature which makes the difference in filtration performance compared with the woven or gridlike planar fabric structures. Theoretically, it is the fiber distance distribution along the cross-section that allows partial penetration of the soil into the nonwoven geotextile. With increasing penetration, the structure of the soil apparently becomes loftier, the particles together with the fibers thus forming a coarse filter at the points of sedimentation. In an effort to apply functional design to a geotextile, filter criteria were created based on laboratory tests and in a few cases on practical experience. These filter criteria are based on the effective opening size (EOS) of the geotextile. Opening size for woven fabrics is relatively easy to determine; however, nonwoven, mechanically needle-punched fabrics are more difficult, requiring indirect measurements. Dry and wet sieving have both been used with marginal success, and deviations in results are frequent. Site conditions and specific geotextile applications will generally govern the requirements for placement and construction using fabrics. Care must be taken during storage and placement to avoid damage and contamination of the fabric. When the geotextile is acting as a filter, any damage will greatly affect the filtering characteristics and possibly cause washout of supporting subgrade fines and subsequent localized failure. (See also W90-08126) (Lantz-PTT)
W90-08130

SOIL REINFORCEMENT DESIGN USING GEOTEXTILES AND GEOGRIDS.

GeoServices, Inc., Boynton Beach, FL.
R. Bonaparte, R. D. Holtz, and J. P. Giroud.
IN: Geotextile Testing and the Design Engineer. ASTM Special Technical Publication 952, 1987. American Society for Testing and Materials, Philadelphia, PA. p 69-116, 27 fig, 2 tab, 45 ref.

Descriptors: *Design standards, *Erosion control, *Geotextiles, *Materials testing, *Soil stabilization, Geosynthetic materials, Performance evaluation, Soil structure, Tensile stress.

The design of soil structures reinforced with polymeric materials is reviewed. Applications for soil reinforcement are categorized according to the type of soil structure, type of load, and function and location of reinforcement. Most current design procedures are based on simple extensions of classical limit equilibrium analyses. Properties of polymeric reinforcement relevant to design are presented. They are subdivided into tensile properties and soil reinforcement interaction properties. Use of wide-strip, constant-load creep tests is recommended for evaluation of tensile properties for design of permanent soil structures. Soil reinforcement interaction characteristics are evaluated in terms of direct sliding of soil over reinforcement and pull-out of reinforcement from soil. Direct sliding characteristics should be evaluated using the direct shear test. Pullout characteristics for geotextiles can be approximated from direct shear test results; however, pullout characteristics for geogrids must be evaluated using pullout tests. Simple limit equilibrium design analyses are illustrated for three of the most commonly encountered types of reinforced soil structures; reinforced slopes, reinforced soil walls, and reinforced embankments over weak foundations. Specific recommendations are made on determination of reinforcement properties for design of these three types of structures. (See also W90-08126) (Author's abstract)
W90-08132

ROUGHNESS EFFECTS ON FLOW AND SHEAR STRESS NEAR OUTSIDE BANK OF CURVED CHANNEL.
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
For primary bibliographic entry see Field 8B.
W90-08257

SEMIARID SOIL AND WATER CONSERVATION.
For primary bibliographic entry see Field 3F.
W90-08532

ENGINEERING MEASURES FOR SOIL AND WATER CONSERVATION TERRACING AND BENCHING.
Finkel and Finkel, Yoqneam (Israel).
H. J. Finkel.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 85-91, 5 fig, 16 ref.

Descriptors: *Benching, *Land management, *Semiarid lands, *Soil conservation, *Terracing, *Water conservation, Cultivation, Erosion control, Semiarid climates, Soil loss, Water loss.

Terracing refers to the broad-based terrace constructed in the form of a ridge and channel, the entire surface of which is cultivated as part of the field. The first broad-based terraces were developed in the humid eastern part of the U.S. to shorten the length of the slopes for reduction of soil erosion, and to lead off surplus storm water at a safe velocity to a protected outlet, usually a grassed waterway. This 'drainage type' terrace is not suitable for semiarid regions, where every effort is taken to retain water on the field, while preventing both local waterlogging and soil erosion. This is accomplished by the 'absorption type' terrace. The most important absorption type of parallel terrace for the semiarid regions if the flat channel terrace, or as it is sometimes known, the Zingg conservation bench terrace. The bed of the channel is level in the transverse direction and the water is retained by a low ridge. The width of the

channel bed depends upon the slope of the land, the allowable depth of cut to subsoil, and the width of the machinery which will be used to construct the terrace. The channel grade should be as small as possible consistent with the following principles: (1) maximum conservation of rain water with minimum discharge to the outlet, and (2) ponded water should not remain in the channel for longer than 48 hr. If the soil has high infiltration rate the channel grade may be zero. Benching, or bench terracing, refers to the practice of converting a sloping field into a series of almost level areas or steps. It has also been called 'staircase farming'. The step may be of varying width in inverse ratio to the degree of slope of the land. Another factor affecting the optimum width of the bench is the depth to which the soil may be cut along the upper margin of the bench. For a 10% slope, if the maximum allowable cut is 0.50 m, the width of the bench would be 10 m. Another consideration affecting the slopes of the ground surface behind the wall is the expected amount of runoff. The effect of bench terracing on the rate of soil loss is very great. If the benches are almost level, and the intervening walls are made of stone, the soil loss will be practically zero, unless an unusual storm exceeds the capacity of the benches to hold water behind the freeboard of the wall, and overtopping occurs. (See also W90-08532) (Lantz-PTT)
W90-08538

GULLY CONTROL.
Finkel and Finkel, Yoqneam (Israel).
H. J. Finkel.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 103-108, 4 fig, 1 ref.

Descriptors: *Erosion control, *Gullies, *Semiarid lands, *Soil erosion, Channel flow, Dams, Diversion, Hydraulic design, Hydraulic profiles, Rills, Slope protection, Slope stabilization.

The gully is the most obvious and spectacular form of soil erosion as it causes large, unsightly gashes in the landscape. Gullies appear in several forms, each of which has different characteristics and requires different methods of control. The two principal types are the so-called V and U gullies. V gullies are characterized by a V-shaped cross section, and generally appear on sloping field. The longitudinal gradient of the channel is greater than the slope of the land. The erosion is in the form of downward cutting in the center of the channel, causing it to become deeper as well as to grow backward, i.e., up the slope. Because this type of gully forms on the more hilly lands, the distance back to the watershed divide is generally shorter and the catchment area feeding the gully is small. V-shaped gullies often develop from rill erosion, when the water is concentrated from several rills into one channel. The best way to avoid the formation of gullies is to protect the area by contour cultivation, strip cropping, and where necessary, terracing. However, once the gully is formed, the following engineering and agronomic measures are required to control it: (1) elimination; (2) diversion; (3) check dams; and (4) treatment of the sides. The U-type gully is recognized by its U-shaped cross section. The longitudinal slope of the channel bottom is usually parallel to the slope of the land through which it passes. It occurs on land with low slopes, almost approaching zero, and is often a source of surprise to travelers who do not expect to see such serious erosion on broad plains. In such flat topography the distance back to the watershed divide is relatively long, and the catchment areas are consequently large. The active erosion of the U-type gully is in the sidewalls and the headwall as a result of undercutting at the base of the vertical cut. These are logical points of control. The methods employed are quite different from those for the V-type, and should have the following sequence: (1) raising the datum--raise the baseline by means of a series of permanent, impermeable drop structures; (2) reshaping the walls; and (3) stabilizing the channel. (See also W90-08532) (Lantz-PTT)
W90-08540

WIND EROSION.
Finkel and Finkel, Yoqneam (Israel).

H. J. Finkel.
IN: Semiarid Soil and Water Conservation. CRC Press, Inc., Boca Raton, Florida. 1986. p 109-121, 3 fig, 3 tab, 16 ref.

Descriptors: *Erosion control, *Semiarid lands, *Soil erosion, *Wind erosion, Barriers, Calcium carbonate, Mulches, Organic matter, Soil moisture, Soil texture, Vegetation effects, Wind velocity.

Wind erosion occurs mainly in the semiarid and subhumid climates and is one of the most serious hazards which threaten the agriculture of those regions. When wind blows across a rough ground surface the friction, or drag, reduces the velocity at the interface, and creates turbulence which exists up to a certain height above the ground. When the velocity of the wind is measured at different heights it is found to increase in proportion to the logarithm of the height, within the zone of turbulence. When the wind blows over a dry sandy field or other erodible soil surface it is found that the wind speed near the ground is reduced and the drag velocity has a different gradient than over a firm, noneroding surface. This is because the saltation of the detached particles creates a zone of interference within a certain height above the ground. All the different drag velocities on an eroding surface pass through a common point. The velocity at this point is a constant regardless of the strength of the wind and is actually the threshold velocity, or the velocity causing incipient detachment of the soil particle. For a stronger wind, the velocity below the height is actually lower because more eroded particles are mixed into the air. This is also a function of the soil erodability. The greater the erodability, the greater the reduction of the wind velocity near the ground. The capacity of a given wind to detach and transport eroded material is not the same as the amount actually eroded by the same wind under given conditions. The erosive capacity of the wind is modified, among other things, by the erodability of the soil. This, in turn, is influenced by soil texture, structure, moisture, organic matter, and lime. Wind causes three general types of damage: loss of soil through erosion, harm to crops, and contamination of the atmosphere by dust. There are many measures which can be taken to reduce the severity of these types of damages. They may be divided into two broad categories: reduction of the force of the wind, and protection of the surface of the soil. These measures include: (1) vegetative cover; (2) the field--the size, shape, and orientation of the field all have an influence on the erodability of the soil and wind damage to the crops; (3) crop residues and minimum tillage; (4) mulches; and (5) barriers. (See also W90-08532) (Lantz-PTT)
W90-08541

DEFINITE PROJECT REPORT WITH ENVIRONMENTAL ASSESSMENT FOR SECTION 14, EMERGENCY STREAMBANK PROTECTION, DES MOINES RIVER, COUNTY ROAD J-12, WAPELLO COUNTY, IOWA.
National Research Council, Washington, DC. Committee on Data Needs.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A203-621. Price codes: A04 in paper copy, A01 in microfiche. September 1988. 49p, 5 tab, 5 append.

Descriptors: *Bank stabilization, *Des Moines River, *Estimated costs, *Iowa, *Project planning, *Stream banks, Assessments, Bank protection, Evaluation, Jetties, Management planning, Riprap, Slope stabilization.

A summary is given of a study made on providing emergency stream bank protection along the right descending bank of the Des Moines River, to curtail erosion which is endangering a portion of County Road J-12 in Wapello County, Iowa. Three alternatives were considered: (1) riprap on a filter fabric blanket and earth fill with seeding; (2) rock jetties; and (3) road relocation. Analysis showed that alternative 1, Iowa Class riprap on a filter fabric blanket and the placement of earth fill with seeding, is the least costly while maximizing net benefits, and would quickly provide an effective means for curtailing the erosion which has placed County Road J-12 in imminent danger. The proposed work consists of approximately 5,000 tons of Iowa Class riprap on a filter fabric blanket, and approximately 1,500 cu yd of earth fill, along 615 linear feet of the right descending bank of the Des Moines River. The total estimated cost for the project is $160,300, with a benefit-to-cost ratio of 2.6. (Lantz-PTT)
W90-08558

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

DEVELOPMENT OF CRITICAL LIFE STAGE ASSAYS: TERATOGENIC EFFECTS OF ASH BASIN EFFLUENT COMPONENTS ON FRESHWATER FISH, GAMBUSIA AFFINIS AND DAPHNIA.
Voorhees Coll., Denmark, SC.
For primary bibliographic entry see Field 5C.
W90-07511

GROUNDWATER MONITORING: GUIDELINES AND METHODOLOGY FOR DEVELOPING AND IMPLEMENTING A GROUNDWATER QUALITY MONITORING PROGRAM.
Kaman Tempo, Santa Barbara, CA.
L. G. Everett.
Genium Publishing Corporation, Schenectady, New York. 1984. 440p.

Descriptors: *Groundwater quality, *Handbooks, *Monitoring, *Network design, *Water analysis, Agricultural runoff, Costs, Databases, Economic aspects, Geohydrology, Groundwater pollution, Irrigation-return flow, Landfills, Leachates, Model studies, Municipal wastewater, Oxidation ponds, Saturation zone, Septic wastewater, Vadose zone, Waste disposal, Water pollution control, Water pollution sources.

The handbook attempts to structure a cost-effective, generic groundwater pollution monitoring methodology that can be applied either on a regional basis or to site-specific, alternative approaches to monitoring the quality of groundwater at a considerable saving of time and money. Extensive detail is given to the relation of groundwater quality to the geohydrologic framework, constituents in the polluted groundwater, sources and causes of pollution, and use of water. Information is also given about groundwater monitoring techniques used in top soil, the vadose zone, and the saturated zone. The costs of these techniques are described in figures and tables. Groundwater databases and their applicability to water resources information systems are also covered. Comprehensive site-specific examples are given of how to use the material in the handbook to monitor major sources of groundwater pollution. Included are in-depth models of hazardous waste disposal, brine disposal, landfill leachate control, oxidation ponds and percolation ponds, septic fields, and agricultural return flow, as well as descriptions of cases of multiple-source municipal and agricultural pollution. (Lantz-PTT)
W90-07514

PROBLEMS AND ANALYTICAL METHODS FOR THE DETERMINATION OF TRACE METALS AND METALLOIDS IN POLLUTED AND NONPOLLUTED FRESHWATER ECOSYSTEMS.
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemie.
M. Stoeppler.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 77-96, 1 fig, 2 tab, 175 ref.

Descriptors: *Instrumentation, *Measuring instruments, *Metal complexes, *Path of pollutants, *Pollutant identification, *Trace metals, *Water analysis, Aluminum, Arsenic, Cadmium, Chemical

Group 5A—Identification Of Pollutants

analysis, Chromium, Cobalt, Copper, Detection limits, Estuaries, Heavy metals, Laboratory methods, Lakes, Lead, Mercury, Nickel, Rivers, Selenium, Thallium, Tin, Zinc.

Trace metals and metalloids in freshwater ecosystems such as lakes, rivers, and estuaries occur either dissolved or bound to particulate matter. Total amounts and concentration ratios (dissolved/particulate bound) depend on the aquatic chemistry of the elements considered, on man-made and geological impacts, and on general properties of the respective aquatic ecosystem. The present state of the art, reliable approaches for the quantitation of dissolved and particulate-bound stages from sampling to final determination for 13 important metals and metalloids in fresh water, is reviewed. These metals are Al, As, Cd, Co, Cr, Cu, Hg, Ni, Pb, Se, T, Zn, and thallium. Preparation of freshwater samples for subsequent analytical determinations strongly depends on the elements to be determined and the methods to be applied. While acidification is sufficient for filtrates and most elements above determination limit, if graphite furnace atomic absorption spectrometry (GFAAS) and total reflection X-ray fluorescence (TXRF) (the latter only if the concentration of interfering matter is low) have to be applied, voltammetry for those samples often requires a particular pretreatment. That usually consists of UV irradiation to decompose dissolved organic matter (DOM) which might interfere with voltammetric analysis due to complexation and electrode reactions. Samples from rivers and estuaries can be particularly affected by DOM. Since the risk of contamination during UV irradiation can be significant due to corroding connections and solders of UV lamps, specially designed irradiation devices have been developed to avoid contamination. Besides voltammetric methods and a few very sensitive modes of AAS (graphite tube furnace, hydride, and cold vapor techniques), other—mainly multielement--methods are in increasing use for the determination of trace and ultratrace elemental levels in fresh water: inductively coupled plasma atomic emission spectroscopy; instrumental neutron activation analysis; stripping voltammetry; multielement methods; square wave voltammetry; adsorption voltammetry; hanging mercury drop electrode; and, mercury film electrode. (See also W90-07522) (Lantz-PTT)
W90-07526

SINGLE SPECIES TOXICITY TESTS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 5C.
W90-07540

FISH AS 'BIOLOGICAL MODEL' FOR EXPERIMENTAL STUDIES IN ECOTOXICOLOGY.
Bordeaux-I Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
For primary bibliographic entry see Field 5C.
W90-07541

ECOTOXICITY TESTING USING AQUATIC BACTERIA.
Centre des Sciences de l'Environment, Metz (France). Dept. of Microbiology.
For primary bibliographic entry see Field 5C.
W90-07543

LABORATORY AND FIELD TECHNIQUES IN ECOTOXICOLOGICAL RESEARCH: STRENGTHS AND LIMITATIONS.
National Fisheries Contaminant Research Center, Columbia, MO.
For primary bibliographic entry see Field 7B.
W90-07545

APPLIED ECOTOXICOLOGY AND METHODOLOGY.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5C.
W90-07547

WATER SAMPLING.
For primary bibliographic entry see Field 7B.
W90-07553

COMPARISONS OF THREE METHODS TO DETERMINE THE VERTICAL STRATIFICATION OF PORE FLUIDS.
Nevada Univ., Reno.
For primary bibliographic entry see Field 7B.
W90-07599

EFFECTS OF ACCESS TUBE MATERIAL AND GROUT ON NEUTRON PROBE MEASUREMENTS IN THE VADOSE ZONE.
Metcalf and Eddy, Inc., Santa Barbara, CA.
For primary bibliographic entry see Field 7B.
W90-07600

MONITORING GROUND WATER FOR PESTICIDES AT A GOLF COURSE - A CASE STUDY ON CAPE COD, MASSACHUSETTS.
Horsley Witten Hegermann, Inc., Barnstable, MA.
S. W. Horsley, and J. A. Moser.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 101-108, Winter 1990. 5 fig, 3 tab, 5 ref.

Descriptors: *Data acquisition, *Monitoring wells, *Pesticides, *Pollutant identification, *Sampling, *Water quality control, Case studies, Fertilizers, Groundwater pollution, Irrigation practices, Model studies, Nitrates, Nitrogen, Path of pollutants.

The town of Yarmouth, Massachusetts proposed to locate a new municipal golf course within a delineated area of recharge to public water supply wells. Officials were concerned with both hydrologic impacts upon supply wells, and water quality impacts from fertilizers and pesticides. The sand and gravel aquifer underlying the golf course was modeled using a three-dimensional finite difference flow model to determine optimum locations and pumping rates for irrigation wells. Fertilizer and pesticide requirements were reviewed by the EPA based upon leachability, mobility, toxicity, and background concentrations. Potential nitrate-nitrogen concentrations in the groundwater were predicted to range from 5.0 to 7.9 mg/L no slow-release fertilizers were recommended. A monitoring program was developed that included (1) specifications for monitoring wells and lysimeters, (2) a sampling schedule, (3) specific concentrations of nitrates or pesticide compounds that require resampling and analysis, restriction of usage, or remedial action, and (4) regular reports to appropriate regulatory agencies. The monitoring facilities were installed with minimal problems during golf course construction. However, implementation of the program was difficult and required cooperation and financial assistance from several state agencies. (Tappert-PTT)
W90-07601

THREE STUDIES USING CERIODAPHNIA TO DETECT NONPOINT SOURCES OF METALS FROM MINE DRAINAGE.
Environmental Protection Agency, Denver, CO. Region VIII.
D. R. Nimmo, M. H. Dodson, P. H. Davies, J. C. Greene, and M. A. Kerr.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 7-15, January/February 1990. 5 fig, 6 tab, 11 ref.

Descriptors: *Bioindicators, *Daphnia, *Mine drainage, *Nonpoint pollution sources, *Pollutant identification, Chromium, Copper, Heavy metals, Mine wastes, Surface water, Trout, Zinc.

Plant and animal species have long served as biomonitors or indicators of environmental quality. Since its introduction, Ceriodaphnia dubia, a small planktonic daphnid, has been widely used for biomonitoring point source discharges. This species was used to determine nonpoint sources of metals and related contaminants in three trout streams in the west where mining activities have been widespread. Acute tests lasting 48 hours and chronic

tests lasting 7 days were conducted. Along Chalk Creek, Colorado, specific tailings (and impacted tributaries) were sources of metals toxic to fish using the water in a hatchery. Using daphnids as an indicator, zinc from degraded tailings was identified as the primary toxic chemical. At stations below extensive mine tailings in the upper Clark Fork River, Montana, drainage was acutely and chronically toxic to daphnids and paralleled reduced or nonexistent populations of trout. Copper was identified as the likely toxic chemical at this site. In Whitewood Creek, South Dakota, reduced toxicity below a gold mine suggested that fish could live in the stream segment previously impaired by the mine. Toxicity downstream revealed a previously unknown nonpoint source of chromium. Biomonitoring using daphnids permitted the re-establishment of the trout fishery sooner than would have been possible otherwise. (Tappert-PTT)
W90-07621

UNRELIABILITY OF KF AGAR TO RECOVER FECAL STREPTOCOCCUS FROM TROPICAL MARINE WATERS.
Hawaii Univ., Honolulu. Water Resources Research Center.
R. S. Fujioka, A. A. Ueno, and O. T. Narikawa.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 27-33, January/February 1990. 1 fig, 9 tab, 12 ref. Hawaii Department of Health , Contract No. Adm. Serv. Log No. 83-31.

Descriptors: *Agars, *Bacterial analysis, *Bioindicators, *Clostridium, *Culture media, *Streptococcus, *Water analysis, Coliforms, Hanauma Bay, Hawaii, Seawater, Tropical regions, Wastewater pollution.

Fecal streptococcus (FS) is the most often used alternative indicator bacteria to assess the hygienic quality of waters. 'Standard Methods' reports that the reliability of recovering fecal streptococcus on KF agar is almost 100%. This study of nonfecal streptococcus bacteria present in the marine waters of Hawaii indicates that non-FS will grow and form false positive colonies similar to that of fecal streptococcus bacteria on KF agar. The primary sampling site was Hanauma Bay beach on the southeastern coast of Oahu, the location of a swimming-related diarrhea episode in 1982. Most of the samples were collected from an area where swimming density was highest, and which was also subject to runoff from public showers, cesspools, restrooms, and rain. Beach waters were collected 3 to 6 m from shore at a depth of 0.5 to 1.0 m and assayed for bacteria by the membrane filtration technique. Four different indicator bacteria were used to evaluate the quality of the water. The samples had consistently low counts of fecal coliform and Clostridium perfringens, indicating that the beach water was not substantially contaminated with fecal matter, yet had yielded high presumptive counts of FS. It is concluded that KF agar should not be used to analyze tropical marine waters for fecal streptococcus, and the use of MEC agar is recommended. (Tappert-PTT)
W90-07623

POLYCYCLIC AROMATIC HYDROCARBONS AS AN INDICATOR OF CONTAMINATION OF MEDICINAL WATERS IN THE SPAS IN THE SUDETES MOUNTAINS OF SOUTHWESTERN POLAND.
Akademia Medyczna, Poznan (Poland). Dept. of Inorganic and Analytical Chemistry.
T. Babelek, and W. Ciezkowski.
Environmental Geology and Water Sciences EGWSEI, Vol. 14, No. 2, p 93-97, September/October 1989. 3 tab, 7 ref.

Descriptors: *Poland, *Pollutant identification, *Polycyclic aromatic hydrocarbons, *Resorts, Benz(a)pyrene, Drinking water, Health resorts, Standards, Tritium.

Studies have shown the necessity of analyzing spa waters for their chemical composition and in particular for their polycyclic aromatic hydrocarbons (PAH) content, especially since spa water is used

in drinking therapy. Earlier work showed increased levels of PAHs in selected spa water at Polish health resorts. Thirteen PAHs have been identified in spa waters of 10 different health resorts in the Sudetes region of Poland. In some of the waters the amount of PAHs exceeded the standard limits set for drinking water (total admissible amount of six typical hydrocarbons is 200 ng/cu dm) set by the World Health Organization. In most cases, a relation exists between the amount of PAHs and tritium, indicating the presence of groundwater. In five cases, benzo(a)pyrene content was found to exceed the admissible concentration for potable water. It is recommended that routine analysis for PAHs in spa water should be performed in waters of southwestern Poland. (Mertz-PTT)
W90-07655

DETERMINATION OF ARSENIC IN ENVIRONMENTAL SAMPLES BY INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY WITH AN IN SITU NEBULIZER/HYDRIDE GENERATOR.
Occidental Chemical Corp., Grand Island, NY. Grand Island Technology Center.
J. D. Hwang, H. P. Huxley, J. P. Diomiguardi, and W. J. Vaughn.
Applied Spectroscopy APSPA4, Vol. 44, No. 3, p 491-496, March/April 1990. 4 fig, 4 tab, 21 ref.

Descriptors: *Arsenic, *Emission spectrometry, *Pollutant identification, Detection limits, Economic aspects, Interference, Testing procedures.

A simple and very inexpensive in situ nebulizer/hydride generator was used with Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) for the determination of arsenic in environmental samples. The applications of hydride generation ICP-AES eliminated the spectral interference and sensitivity problem of arsenic determination encountered when conventional pneumatic nebulization was used for sample introduction. The key features of this study which distinguish it from previous works in this field are: (1) it greatly reduces the amount of time needed for sample preparation; (2) only a minimal and inexpensive modification of existing standard equipment is required; and (3) only a low-/medium-power plasma is required, in contrast to the high-power plasma required with other methods. This method has a detection limit of 1 ng/mL of the As 193.759-nm line and 2 ng/mL of the As 228.812-nm line, respectively. The linear calibration range is over 3 orders of magnitude, starting from the detection limit. (Author's abstract)
W90-07662

DETECTION OF COLIFORM BACTERIA IN WATER BY POLYMERASE CHAIN REACTION AND GENE PROBES.
Louisville Univ., KY. Dept. of Biology.
A. K. Bej, R. J. Steffan, J. DiCesare, L. Haff, and R. M. Atlas.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 2, p 307-314, February 1990. 7 fig, 30 ref.

Descriptors: *Bacterial analysis, *Bioindicators, *Coliforms, *Pollutant identification, Biochemical tests, DNA, Pathogenic bacteria, Polymers, Selectivity, Water quality.

Coliform bacteria are used for monitoring the bacteriological safety of water supplies since the presence of coliform bacteria in water is an indicator of potential human fecal contamination and therefore the possible presence of enteric pathogens. Polymerase chain reaction (PCR) amplification and gene probe detection of regions of two genes, lacZ and lamB, were tested for their abilities to detect coliform bacteria. Amplification of a segment of the coding region of Escherichia coli lacZ by using a PCR primer annealing temperature of 50 C detected E. coli and other coliform bacteria (including Shigella spp.), but not Salmonella spp. and noncoliform bacteria. Amplification of a region of E. coli lamB by using a primer annealing temperature of 50 C selectively detected E. coli and Salmonella and Shigella spp. PCR amplification and radiola-

beled gene probes detected as little as 1 to 10 fg of genomic E. coli DNA and as few as 1 to 5 viable E. coli cells in 100 mL of water. PCR amplification of lacZ and lamB provides a basis for a method to detect indicators of fecal contamination of water, and amplification of lamB in particular permits detection of E. coli and enteric pathogens (Salmonella and Shigella spp.) with the necessary specificity and sensitivity for monitoring the bacteriological quality of water. (Author's abstract)
W90-07686

ENUMERATION AND BIOMASS ESTIMATION OF PLANKTONIC BACTERIA AND VIRUSES BY TRANSMISSION ELECTRON MICROSCOPY.
Bergen Univ. (Norway). Dept. of Microbiology and Plant Physiology.
For primary bibliographic entry see Field 7B.
W90-07688

ENUMERATION OF TOTAL COLIFORMS AND ESCHERICHIA COLI FROM SOURCE WATER BY THE DEFINED SUBSTRATE TECHNOLOGY.
Yale Univ., New Haven, CT. Dept. of Lab. Medicine.
S. C. Edberg, M. J. Allen, D. B. Smith, and N. J. Kriz.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 2, p 366-369, February 1990. 3 fig, 1 tab, 19 ref.

Descriptors: *Bacterial analysis, *Bioindicators, *Coliforms, *Colorimetry, *Pollutant identification, *Sensitivity analysis, Comparison studies, Monitoring, Pathogenic bacteria, Selectivity, Substrates, Water analysis, Water quality.

Many water utilities are required to monitor source water for the presence of total coliforms, fecal coliforms, or both. The Colilert system, an application of the defined substrate technology, simultaneously detects the presence of both total coliforms and Escherichia coli directly from a water sample. After incubation, the formula becomes yellow if total coliforms are present and fluorescent at 366 nm if E. coli is in the same sample. No confirmatory tests are required. The Colilert system was previously assessed with distribution water in a national evaluation in both most-probable-number and presence-absence formats and found to produce data equivalent to those obtained by using Standard Methods for the Examination of Water and Wastewater (Standard Methods). The Colilert system was compared with Standard Methods multiple-tube fermentation (MTF) for the enumeration of total coliforms and E. coli from surface water. All MTF tubes were confirmed according to Standard Methods, and subcultures were made to identify isolates to the species level. Colilert tubes were subcultured to determine if color changes were specific to the target microbes. The Colilert system was found equally sensitive to MTF testing by regression, t test, chi-square, and likelihood fraction analyses. Specificity of the Colilert system was shown by the isolation of a species of total coliform or E. coli after the appropriate color change. The Colilert test can be used for source water samples when enumeration is required, and the benefits previously described for distribution water testing, i.e., sensitivity, specificity, less labor, lower cost, faster results, no noncoliform heterotroph interference, are applicable to this type of water analysis. (Author's abstract)
W90-07689

RAPID DETECTION OF CHLORINE-INDUCED BACTERIAL INJURY BY THE DIRECT VIABLE COUNT METHOD USING IMAGE ANALYSIS.
Montana State Univ., Bozeman. Dept. of Microbiology.
A. Singh, F. P. Yu, and G. A. McFeters.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 2, p 389-394, February 1990. 2 fig, 3 tab, 27 ref. U.S. Geological Survey Grant 14-08-001-G1493 and NASA Grant NAG-9-241.

Descriptors: *Bacterial analysis, *Bactericides, *Chlorination, *Coliforms, *Culturing techniques, Chlorine, Image analysis, Microscopic analysis, Water quality.

A modified direct viable count method to detect living bacteria was used with image analysis for the rapid enumeration of chlorine-injured cells in an Escherichia coli culture. The method was also used for determining chlorine-induced injury in coliform isolates and enteric pathogenic bacteria. Cultures were incubated in phosphate-buffered saline, containing 0.3% Casamino Acids, 0.03% yeast extract, and optimal concentrations of nalidixic acid. Samples were withdrawn before and after incubation and stained with acridine orange, and cell lengths and breadths were measured by computerized image analysis. After incubation, cells which exceeded the mean preincubation length (viable cells) were enumerated and the results were compared with those obtained by the plate count method. Injury in the chlorine-exposed cell population was determined from the difference in viable count obtained with a nonselective Casamino Acids/yeast extract/nalidixic acid medium and a selective Casamino Acids/yeast extract/nalidixic acid medium containing sodium deoxycholate or sodium lauryl sulfate. The levels of injury determined by the direct viable count technique by using image analysis were comparable to those determined by the plate count method. Results showed that image analysis, under optimal conditions, enumerated significantly higher numbers of stressed E. coli than the plate count method did and detected injury in various cultures in 4 to 6 hours. (Author's abstract)
W90-07690

CHANGES IN COMMUNITY STRUCTURE AND PRODUCTIVITY OF PHYTOPLANKTON AS INDICATORS OF LAKE AND RESERVOIR EUTROPHICATION.
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
For primary bibliographic entry see Field 2H.
W90-07745

PHYTOPLANKTON OF RESERVOIRS IN RELATION TO THE TROPHIC POTENTIAL OF INFLOW WATER.
Vyzkumny Ustav Vodohospodarsky, Brno (Czechoslovakia).
For primary bibliographic entry see Field 2E.
W90-07746

DEVELOPMENT OF PURGE AND TRAP WITH WHOLE COLUMN CRYOTRAPPING FOR THE ANALYSIS OF GROUNDWATER CONTAMINATED WITH ORGANIC CHEMICALS.
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
J. F. Pankow.
Available from National Technical Information Service, Springfield, VA 22161 as PB90-159245/AS. Price codes: A03 in paper copy, A01 in microfiche. Final Report, 1989. 17p, 6 fig, 1 tab, 29 ref. USGS Contract no. 14-08-0001-G1135.

Descriptors: *Analytical techniques, *Pollutant identification, *Volatile organic compounds, *Water analysis, Gas chromatography, Groundwater analysis, Mass spectrometry, Purgeables analysis.

A method has been developed for the determination of volatile organic compounds in water. It involves the direct purging of a sample to a fused silica capillary column. As they are purged, the compounds are focussed on a DB-624 column (0.32 or 0.53 mm i.d.) using whole column cryotrapping (WCC). WCC at minus 90 to minus 80 C traps all of the purgeable priority pollutant compounds. After purging, the gas chromatography run is started immediately. This purge and whole column cryotrapping (P/WCC) method is facilitated by the fact that water is relatively nonvolatile; at 20 C, the equivalent of only 0.9 microL of liquid water is transported to the column for every 50 ml

of purge gas at the purge vessel pressure. Advantages of P/WCC include: (1) simplicity and therefore high reliability; (2) low background contamination since no sorbent traps or multiport valves are needed; (3) no need to retain very volatile compounds on an intermediate trap as in purge and trap; and (4) very short run times. (USGS)
W90-07857

PROBLEMS ASSOCIATED WITH IDENTIFICATION OF LEGIONELLA SPECIES FROM THE ENVIRONMENT AND ISOLATION OF SIX POSSIBLE NEW SPECIES.
Institute of Medical and Veterinary Science, Adelaide (Australia). Div. of Clinical Microbiology.
I. J. Wilkinson, N. Sangster, R. M. Ratcliff, P. A. Mugg, and D. E. Davos
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 3, p 796-802, March 1990. 2 fig, 4 tab, 20 ref.

Descriptors: *Bacterial analysis, *Laboratory methods, *Legionella, *Pollutant identification, *Taxonomy, Australia, DNA, Fatty acids, Microbiological studies, Water analysis.

Following the investigation of an outbreak of legionellosis in South Australia, numerous Legionella-like organisms were isolated from water samples. Because of the limited number of commercially available direct fluorescent-antibody reagents and the cross-reactions found with some reagents, non-pneumophila legionellae proved to be difficult to identify and these isolates were stored at -70 C for later study. Latex agglutination reagents for Legionella pneumophila and L. anisa were developed and found to be useful as rapid screening aids. Autofluorescence was useful for placing isolates into broad groups. Cellular fatty acid analysis, ubiquinone analysis, and DNA hybridization techniques were necessary to provide definitive identification. The species which were isolated most frequently were L. pneumophila, followed by L. anisa, L. jamestowniensis, L. quinlivanii, L. rubrilucens, L. spiritensis, and a single isolate each of L. erythra, L. jordanis, L. birminghamensis, and L. cincinnatiensis. In addition, 10 isolates were found by DNA hybridization studies to be unrelated to any of the 26 currently known species, representing what is believed to be 6 possible new species. (Author's abstract)
W90-07869

DETERMINING CHEMICAL TOXICITY TO AQUATIC SPECIES: THE USE OF QSARS AND SURROGATE SPECIES.
For primary bibliographic entry see Field 5C.
W90-07882

INTERACTION OF METALS AND PROTONS WITH ALGAE: II. ION EXCHANGE IN ADSORPTION AND METAL DISPLACEMENT BY PROTONS.
Messiah Coll., Grantham, PA.
For primary bibliographic entry see Field 5D.
W90-07884

ASSESSMENT OF FECAL STEROLS AND KETONES AS INDICATORS OF URBAN SEWAGE INPUTS TO COASTAL WATERS.
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
J. O. Grimalt, P. Fernandez, J. M. Bayona, and J. Albaiges.
Environmental Science and Technology ESTHAG, Vol. 24, No. 3, p 357-363, March 1990. 5 fig, 3 tab, 40 ref.

Descriptors: *Bioindicators, *Coastal waters, *Ketones, *Path of pollutants, *Pollutant identification, *Sterols, *Wastewater pollution, Marine sediments, Monitoring, Ocean dumping, Particulate matter, Water pollution sources.

The sterol and sterone compositions of aquatic samples, namely, water particulates and sediments, collected in urban polluted and pristine areas have been investigated for the assessment of steroid components as chemical markers of urban sewage

contamination. Sampling filters placed in coastal waters near or remote from urban sewage outfall sites were analyzed for various sterols and sterones from human feces by gas chromatography and were quantified by comparison with standard solutions. The results show that the occurrence of coprostanol (5-beta(H)-cholestan-3-beta-ol) cannot by itself be unambiguously attributed to fecal matter inputs. However, these contributions can be positively identified when the relative concentrations of this sterol and the related 5-beta(H)-cholestan-3-one (coprostanone) are higher than their corresponding 5-alpha epimers. In this respect, coprostanone provides a useful complementary parameter for urban sewage monitoring, especially in cases of moderate to low pollution. (Author's abstract)
W90-07886

IN SITU DETERMINATION OF PCB CONGENER-SPECIFIC FIRST ORDER ABSORPTION/DESORPTION RATE CONSTANTS USING CHIRONOMUS TENTANS LARVAE (INSECTA: DIPTERA: CHIRONOMIDAE).
New York State Dept. of Environmental Conservation, Albany. Bureau of Water Research.
For primary bibliographic entry see Field 5B.
W90-07913

SHORT-TERM TOXICITY TEST USING ESCHERICHIA COLI: MONITORING CO2 PRODUCTION BY FLOW INJECTION ANALYSIS.
Universidade Estadual de Campinas (Brazil). Inst. de Quimica.
W. F. Jardim, C. Pasquini, J. R. Guimaraes, and L. C. de Faria.
Water Research WATRAG, Vol. 24, No. 3, p 351-354, March 1990. 5 fig, 18 ref.

Descriptors: *Antibiotics, *Bioindicators, *Escherichia coli, *Flow injection analysis, *Heavy metals, *Monitoring, *Pollutant identification, *Toxicity, *Water pollution effects, Bactrin, Cadmium, Carbon dioxide production, Conductometric detector, Copper, Hazard assessment, Mercury, Sediments.

It is important to develop means to screen not only chemicals, but also the quality of potable waters, sediments and any other possible hazardous material for their toxic potential. Short-term toxicity tests using Escherichia coli were carried out for different stressing agents such as metal ions (Cd(II), Cu(II) and Hg(II)), sediments and one type of antibiotic (Bactrin). Inhibition of the microbial respiration was monitored using flow injection analysis with a conductometric detector. Inhibition in the respiration of E. coli suspensions was detected within 20 min for Hg(II) ions and the antibiotic, whereas sediment samples from eutrophic water bodies stimulated carbon dioxide production. (Author's abstract)
W90-07918

SIMPLE ELUTION AND RECONCENTRATION TECHNIQUE FOR VIRUSES CONCENTRATED ON MEMBRANE FILTERS FROM DRINKING WATER SAMPLES.
National Environmental Engineering Research Inst., Nagpur (India).
N. Jothikumar, A. Dwarkadas, and P. Khanna.
Water Research WATRAG, Vol. 24, No. 3, p 367-372, March 1990. 4 fig, 5 tab, 22 ref.

Descriptors: *Human health, *Monitoring, *Pathogens, *Pollutant identification, *Viruses, *Water analysis, *Water treatment, Bacteriophage, Membrane filters, Poliovirus, Urea arginine phosphate.

An optimum concentration of urea (1.5 M)-arginine phosphate (0.2:0.008 M) buffer (U-APB) was designed as an eluent at pH 9.0 for effective desorption and elution of viruses from negatively charged membrane filters. The primary eluate is reconcentrated by the precipitation of magnesium phosphate on addition of magnesium chloride. The flocs are centrifuged, the pellet is dissolved in McIlvaines buffer (pG 5) and neutralized with sodium bicarbonate (8.8%) prior to assay on cell culture. The efficacy of the method has been tested

at different inoculum levels and also for different volumes of water samples seeded with viruses. U-APB gives 92-100 and 88-93% recovery for Poliovirus I and bacteriophage, respectively, as against a 30-40% recovery of Poliovirus I and bacteriophage, respectively, and a meager 30-40% recovery of Poliovirus I in the organic flocculation of beef extract method presently in use. Further, the eluent (U-APB) is easy to constitute and it performs elution and reconcentration of viruses without any pH adjustment. (Author's abstract)
W90-07921

CRITICAL REVIEW OF METHODS USED FOR THE SENSORY EVALUATION OF WATER QUALITY.
California Univ., Berkeley. Dept. of Social Administrative Health Services.
W. H. Bruvold.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 1, p 291-308, January 1990. 5 tab, 17 ref.

Descriptors: *Monitoring, *Odors, *Organoleptic properties, *Taste, *Water quality, Pollutant identification, Testing procedures, Water analysis.

Three methods for assessing water quality, the flavor threshold test (FTT), the flavor rating scale (FRS), and the flavor profile analysis (FPA) were compared and evaluated against a set of ten criteria (selection requirements, training requirements, sample preparation, threshold determination, functional relationships, monitoring treatment, consumer survey use, standard setting, reliability, and validity). The FTT was found inadequate for determining absolute or detection thresholds in deliberate and well-controlled laboratory research. Information gained from research applications of the FTT for detection threshold determination can and should be used to establish maximum contaminant levels for chemical constituents which produce offensive flavors in water. The FTT is not easily adapted to procedural applications for planning, monitoring, and evaluating treatment processes. The best and most defensible application of the FTT is for detection threshold determination for known chemical constituents in an appropriate laboratory setting. The flavor rating scale (FRS) is a reasonable procedure for assessing the overall or global sensory quality of water for daily drinking. The FRS cannot be used in the determination of detection thresholds and is not appropriate for planning and monitoring treatment plant operations; however, it is appropriate for evaluating finished water delivered for human consumption. The strengths of the FRS include its demonstrated ability to develop functional relations that can be used to recommend maximum contaminant levels for flavor producing constituents in water, research conducted to evaluate the reliability of FRS results, and the appropriate use of the FRS in related laboratory panel-consumer survey research in regard to predictive validity. The flavor profile analysis (FPA) is very useful in planning, monitoring, and evaluating the water treatment process, providing the considerable technical and financial resources necessary to support this type of taste panel research are available. The FPA is not designed for determination of detection thresholds and cannot be used to recommend maximum contaminant levels from a detection threshold rationale. Research needs to be conducted to further strengthen the operation of each of the three methods in its appropriate area of application. (Geiger-PTT)
W90-07963

DEGRADATION OF PYRIDINES IN THE ENVIRONMENT.
Ohio State Univ., Columbus. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W90-07964

SIMPLE METHOD FOR MONITORING MUTAGENICITY OF RIVER WATER. MUTAGENS IN YODO RIVER SYSTEM, KYOTO-OSAKA.
Okayama Univ. (Japan). Faculty of Pharmaceutical Sciences.
H. Sakamoto, and H. Hayatsu.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 521-528, April 1990. 4 fig, 1 tab, 12 ref.

Descriptors: *Copper compounds, *Japan, *Mutagenicity, *Pollutant identification, *Water pollution sources, *Yodo River, Adsorption, Bioassay, Katsura River, Monitoring, Rayon, Toxicity.

Blue cotton is a cotton preparation, bearing copper phthalocyanine trisulfonate as a covalently linked ligand, and is an adsorbent specific for compounds with three or greater numbers of fused rings. Due to this special property, blue cotton has been used for extracting mutagenic polycyclic compounds. The blue-rayon method was used to detect mutagenic components in the Yodo river, which flows through the cities of Kyoto and Osaka, and is a major source of drinking water. Blue rayon and plain rayon strands were hung side by side in the Asahi river of Okayama at a site near the mouth of the river, where mutagenicity was previously noted. The rayons were allowed to stand for 2 days in the water and the mutagenicity on Salmonella was assayed. This ligand was clearly effective in adsorbing the mutagens from the river water. These studies demonstrate that at least four strongly mutagenic relatively stable compounds, discharged from the sewage plant, flow down the Katsura river, thereafter constituting the major mutagenic components in the Yodo river. The Yodo river system has been continuously polluted with mutagens for many years. Characterization of these mutagens and identification of their sources require further studies. (Brunone-PTT)
W90-08019

CLEANUP OF SEDIMENT EXTRACTS PRIOR TO PCB ANALYSIS.
Army Engineer Waterways Experiment Station, Vicksburg, MS.
J. M. Brannon, and R. Karn.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 542-548, April 1990. 3 tab, 9 ref.

Descriptors: *Chemical analysis, *Laboratory methods, *Pollutant identification, *Polychlorinated biphenyls, *Sample preparation, *Sediment contamination, Chemical treatment, Gas chromatography, Hydrocarbons, Sulfur.

Data for polychlorinated biphenyls (PCBs) in sediment are often difficult to evaluate because different laboratories use different sediment extraction, extract cleanup, and analytical techniques to obtain the information. Even the use of standardized procedures can produce large differences in PCB results. Prior to quantification of PCBs in sediment samples by gas chromatography, sediment extracts must be processed to remove interfering sample components such as oil and grease, sulfur, and organochlorine insecticides. Four commonly used sediment extract cleanup procedures (fluorisil and mercury, silica gel and mercury, sulfuric acid and mercury, and sulfuric acid and tetrabutylammmonium-sulfite reagent) on oil and grease and sulfur concentrations determined in Chicago River sediment extracts were compared. All cleanup procedures produced a significant lowering of oil and grease and sulfur concentrations. Only small differences in concentrations of total PCBs were noted between treatments. Percent recovery of added PCB was generally similar for all treatments in both sediments. The results in this study were obtained with capillary columns and a confirmatory capillary column that eliminates a large number of false peaks caused by interference. Under these analytical conditions, any of the cleanup procedures used provided acceptable PCB values. (Brunone-PTT)
W90-08022

CHARACTERIZATION OF TRANSMISSIVE FRACTURES BY SIMPLE TRACING OF IN-WELL FLOW.
Whitman Companies, Inc., East Brunswick, NJ.
For primary bibliographic entry see Field 2F.
W90-08188

GENERAL STATISTICAL PROCEDURE FOR GROUND-WATER DETECTION MONITORING AT WASTE DISPOSAL FACILITIES.
Illinois State Psychiatric Inst., Chicago.
For primary bibliographic entry see Field 7A.
W90-08193

SAMPLING RADIUS OF A POROUS CUP SAMPLER: EXPERIMENTAL RESULTS.
Wisconsin Univ.-Madison. Dept. of Soil Science.
For primary bibliographic entry see Field 2F.
W90-08196

COLIPHAGES AS INDICATORS OF HUMAN ENTERIC VIRUSES IN GROUNDWATER.
American Society for Microbiology, Washington, DC.
J. A. Snowdon, and D. O. Coliver.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 3, p 231-249, 1989. 2 tab, 114 ref.

Descriptors: *Bacteriophage, *Bioindicators, *Coliphages, *Enteroviruses, *Human pathogens, *Pollutant identification, *Reviews, Coliforms, Groundwater pollution.

The most common waterborne viral diseases in the US appear to be gastroenteritis, hepatitis A, and possibly rotavirus gastroenteritis. Detection of these enteroviruses is costly and time consuming. Small, single-stranded RNA phages that infect E. coli are likely to be present in all feces-contaminated environmental sources in substantial numbers and are easily detected and differentiated. These coliphages appear to offer some potential as indicators or indices of the presence of enteroviruses. Coliphages are likely to persist in groundwater due to the lack of nutrients, dilution of the bacterial hosts, and cool temperatures. Numerous techniques are available for working with coliphage, although they have been rarely applied to groundwater. Coliphages are both specific and versatile, providing opportunity for experimental manipulation to investigate particular aspects of groundwater pollution. It is possible to discriminate between phage types without great difficulty, based on their host specificity, morphological appearance of their plaques, and serological reactions. Much information exists concerning classification, distribution patterns and the ecological specifics of habitats of different phage types. For these reasons, a coliphage system for accurate prediction of the presence of human enteric viruses in groundwater could be developed. (VerNooy-PTT)
W90-08237

IDENTIFICATION OF AMMONIA AS AN IMPORTANT SEDIMENT-ASSOCIATED TOXICANT IN THE LOWER FOX RIVER AND GREEN BAY, WISCONSIN.
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5C.
W90-08244

BEHAVIOUR OF DIFFERENT ELUENTS AND STABILIZING AGENTS IN THE DETERMINATION OF SULPHITE IN WATER BY ION-CHROMATOGRAPHY.
Rome Univ. (Italy). Dept. of Chemistry.
For primary bibliographic entry see Field 7B.
W90-08294

EVALUATION OF AMMONIUM ION DETERMINATION IN WATERS BY CATION EXCHANGE ION CHROMATOGRAPHY OVER WIDE CONCENTRATION RANGES.
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
B. N. Noller, and N. A. Currey.
Water Research WATRAG, Vol. 24, No. 4, p 471-476, April 1990. 1 fig, 5 tab, 5 ref.

Descriptors: *Ammonium, *Chemical analysis, *Chromatography, *Instrumentation, *Pollutant identification, *Water analysis, Cation exchange, High performance liquid chromatography, Ion exchange chromatography.

The determination of ammonium ion by cation exchange ion chromatography utilizing automated High Performance Liquid Chromatography apparatus was evaluated for a wide range of ammonium ion concentrations and kinds of water samples (rainwater, creek water, mine pond and tailings water). The method is reliable and reproducible over a wide concentrations range from less than 0.05 to 500 mg/l NH(3)-N. The automated method involved minimal handling of sample and sample preparation. An additional benefit of the HPLC technique is the possibility for simultaneous determination of sodium, potassium and lithium during the same analytical run. (Author's abstract)
W90-08390

NUTRIENT AVAILABILITY AND THE ALGAL GROWTH POTENTIAL (AGP) IN A SMALL MICROCOSM.
Baylor Univ., Waco, TX. Dept. of Biology.
For primary bibliographic entry see Field 7B.
W90-08398

CHROMIUM(VI)-RESISTANT YEAST ISOLATED FROM A SEWAGE TREATMENT PLANT RECEIVING TANNERY WASTES.
Siena Univ. (Italy). Dipt. di Biologia Ambientale.
F. Baldi, A. M. Vaughan, and G. J. Olson.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 4, p 913-918, April 1990. 6 fig, 3 tab, 27 ref.

Descriptors: *Bioaccumulation, *Chromium, *Fungi, *Pollutant identification, *Tannery wastes, *Taxonomy, *Yeasts, Classification, Heavy metals, Industrial wastewater, Microbiological studies.

A Cr(VI)-resistant yeast, designated strain DBVPG 6502, was isolated from a sewage plant receiving wastes from tannery industries in Italy. The strain was tentatively identified as a species of Candida based on morphological and physiological analyses. This strain was highly resistant to Cr(VI) when compared with 8 other yeast strains, growing on Cr(VI) concentrations of up to 500 micrograms/ml. This resistance was constitutive; the Cr(VI)-resistant yeast did not reduce Cr(VI) to Cr(III) species under aerobic conditions. The yeast showed very little accumulation of Cr(VI) in the presence or absence of azide, suggesting that the reduced accumulation does not involve metabolism-dependent efflux. Rather, the results suggest that the cell envelope of DBVPG 6502 could be different from that of S. cerevisiae in its chemical affinity for Cr(VI) and/or that metabolism-dependent transport of Cr(VI) does not occur in strain DBVPG 6502. The Cr-resistant isolate designated as strain DBVPG 6502, although showing some phenotypic affinity to some known species of the genera Pichia, Debarvomyees, and Candida, demonstrated differences significant enough to consider it a separate species. In addition, an impermeability of the isolate to chromate, a property not reported in yeast strains, may also support consideration of the isolate as a new species. Since sporulation studies (ongoing) have not revealed a sexual cycle of the strain, it will be considered a new species of the genus Candida until such time as sporulation can be verified. (Sand-PTT)
W90-08426

DIRECT DETECTION OF SALMONELLA SPP. IN ESTUARIES BY USING A DNA PROBE.
Center of Marine Biotechnology, Baltimore, MD.
I. T. Knight, S. Shults, C. W. Kaspar, and R. R. Colwell.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 4, p 1059-1066, April 1990. 4 fig, 4 tab, 37 ref. U.S. Geological Survey Contract 14-08-0001-G1475, Office of Naval Research Contract no. N-00014-86-K-0696, and EPA Cooperative Agreement CR-81-2246-01-0.

Descriptors: *Bacterial analysis, *DNA probe, *Estuaries, *Pollutant identification, *Salmonella, *Water analysis, Bioassay, Chesapeake Bay, DNA, Laboratory equipment, Measuring instruments, Microbiological studies, New York Harbor.

Group 5A—Identification Of Pollutants

A method for direct detection of Salmonella spp. in water was developed by using a commercially available DNA probe. Particulate DNA was extracted from 500-ml to 1500-ml water samples collected from New York Harbor and Chesapeake Bay and used as a substrate for a salmonella-specific DNA probe in dot blot assays. The method detected salmonellae in water samples from 12 of 16 sites, including 6 sites where salmonellae could not be cultured. The specificity of the probe was evaluated, and cross-hybridization, although negligible, was used to set limits for the assay. Salmonella DNA bound the probe quantitatively, and from these results Salmonella DNA in the total particulate DNA in environmental samples could be estimated. The data indicate the Salmonella spp. often are not detected in water samples by culture methods, even when they are present in significant numbers. (Author's abstract) W90-08427

IDENTITY OF CHLORINATED ORGANIC SUBSTANCES IN AQUATIC ORGANISMS AND SEDIMENTS.
Lund Univ. (Sweden). Dept. of Technical Analytical Chemistry.
For primary bibliographic entry see Field 5B.
W90-08448

RESEARCH METHODS FOR DETERMINATION OF VOLATILE ORGANIC COMPOUNDS IN WATER.
New Jersey Dept. of Environmental Protection, Trenton. Office of Science and Research.
C. D. Hertz, and I. H. Suffet.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 39-56, 1 tab, 62 ref.

Descriptors: *Laboratory methods, *Pollutant identification, *Volatile organic compounds, *Water analysis, Chemical analysis, Chemical extraction, Distillation, Organic compounds.

There are a wide range of research methods that can be used to isolate volatile organic compounds from water. While most of these methods are not part of official analytical protocols, they provide the foundation for the official protocols. There are many official protocols based on a number of research methods, such as headspace analysis, distillation, and liquid-liquid extraction. Methods involving closed loop-stripping analysis (CLSA), simultaneous distillation extraction (SDE), or flavor profile analysis (FPA) should be considered for use in official protocols. Each of these methods can be a very powerful analytical tool when applied to an appropriate situation. CLSA and SDE methods can extend the analysis to organics that are less volatile than some of the other methods for VOCs. The FPA method takes advantage of the sensitivity and specificity of human perception and has proven to be very sensitive in certain analyses. While efforts have been made to standardize these procedures within the research community, each of these methods warrants consideration toward developing standardized and approved analytical methods. The objectives of the analysis must be a key concern because they will determine whether a broad spectrum analysis and/or specific compound analysis is appropriate. For research applications, flexibility is usually important and requires that experimental conditions be well defined and justified so that others can adapt the method, if needed, to better suit their needs. (See also W90-08509) (Lantz-PTT)
W90-08512

ANALYTICAL METHODS FOR VOLATILE ORGANIC COMPOUND DETERMINATION.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Quality Assessment Branch.
For primary bibliographic entry see Field 5F.
W90-08513

MINIMIZATION OF VOLATILIZATION LOSSES DURING SAMPLING AND ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN WATER.

Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
J. F. Pankow.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 73-86, 6 fig, 1 tab, 12 ref.

Descriptors: *Chemical analysis, *Pollutant identification, *Sample preservation, *Sampling, *Volatile organic compounds, *Volatilization, *Water analysis, Groundwater, Laboratory methods, Sample preparation.

The acquisition of analytical data for any type of water requires the successful completion of two steps: (1) sampling; and (2) analysis. Data can suffer from either a positive or negative bias. Contamination will cause a positive bias. In the determination of volatile organic compounds (VOCs), contamination can be troublesome. Particularly in low-level work, background contamination levels must often be decreased in order to lower the method detection limits. The negative biases caused by losses of VOCs can also be problematic. Most of the loss processes affecting VOCs involve some type of volatilization mechanism, and all of the VOCs are, by definition, subject to volatilization. Many of the specific processes that can cause volatilization losses may occur both during sampling and during analysis in the laboratory. Often, these processes take place when the sample or the analytes are being physically transferred. Losses of VOCs during sampling and/or analysis can occur in many ways, including: (1) direct degassing to an interface between the water of interest and the atmosphere; (2) the presence of a headspace above the sampled water; (3) the formation of bubbles during a reduction of pressure; (4) the use of inadequate groundwater sampling equipment; and (5) incomplete and variable retention on the trap of a purge and trap analytical device. All of these problems may be dealt with through a combination of careful and thoughtful sampling and analysis skills, the proper sampling equipment, and the use of the purge with whole column cryotrapping method. (See also W90-08509) (Lantz-PTT)
W90-08514

FIBER OPTIC METHODS FOR VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER.
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-08515

NATIONAL SURVEYS OF VOLATILE ORGANIC COMPOUNDS IN GROUND AND SURFACE WATERS.
Environmental Protection Agency, Cincinnati, OH. Water Supply Technology Branch.
For primary bibliographic entry see Field 7B.
W90-08516

PHYSICAL-CHEMICAL PROPERTIES AND FATE OF VOLATILE ORGANIC COMPOUNDS: AN APPLICATION OF THE FUGACITY APPROACH.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 5B.
W90-08519

LONG-TERM AND SEASONAL ASPECTS OF THE WATER QUALITY OF THE RIVER DANUBE WITHIN THE REGION OF VIENNA (AUSTRIA).
Oesterreichisches Inst. fuer Wirtschaftsforschung, Vienna.
For primary bibliographic entry see Field 5B.
W90-08611

PHOSPHATASE ACTIVITY OF WATER AS A MONITORING PARAMETER.
Novi Sad Univ. (Yugoslavia). Inst. of Biology.
M. Matavulj, M. Bokorov, S. Gajin, M. Gantar, and S. Stojilkovic.

Water Science and Technology WSTED4, Vol. 22, No. 5, p 63-68, 1990. 3 fig, 1 tab, 17 ref.

Descriptors: *Monitoring, *Phosphatases, *Pollutant identification, *Water analysis, Aquatic organisms, Bacterial physiology, Bioassay, Enzymes, Path of pollutants, Trophic level, Water quality control.

The biological monitoring of water saprobity and trophic degree primarily involves the study of qualitative and quantitative composition of organisms present in the water. Although relatively satisfactory as an indicator of the organic load, the counting of bacteria is often an unreliable parameter. Due to their polyenzymatic nature, which enables flexible adaptation to new and different physico-chemical conditions in their habitats, microorganisms respond quickly to trophic degree change; this happens faster by changing the level of their enzyme activity, than by changing their number of cells. On the basis of these findings, the enzyme activity of the aquatic microbial biotope population is suggested as an additional indicator of the degree of organic load in the water. Results obtained from investigating the phosphatase activity of natural and artificial water accumulations, and flow waters, in Vojvodina Province, suggest that measuring the level of water enzyme activity might be an additional biochemical indicator of saprobity degree. On the basis of long-term measurements of the water phosphatase activity, classification of surface freshwaters into quality categories according to the level of enzyme (phosphatase) activity of water is proposed. (Agostine-PTT)
W90-08613

SOME ASPECTS OF POLLUTION OF THE DANUBE.
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 5B.
W90-08617

WATER BIOLOGICAL SUFFICIENCY AND QUALITY OF THE BULGARIAN DANUBE STRETCH (845-375 RIVER KM).
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
Y. I. Uzunov, and B. K. Russev.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 99-105, 1990. 1 fig, 2 tab, 19 ref.

Descriptors: *Water pollution, *Water quality, *Water quality standards, Benthic environment, Bottom sediments, Monitoring, Path of pollutants, River sediments, Standards, Water quality control.

The possibility of categorizing water biological sufficiency and quality through criteria for state biotic standards has been evaluated for 7 sections of the Bulgarian Danube River stretch. The results of saprobiological analysis show the relatively stable beta-mesosaprobic level of the entire studied stretch. Indices of the structural organization of the benthic invertebrate communities do not correspond to this but rather to the status of zoobenthos in different types of bottom substrata distributed over the length and width of the stretch. Indices and norms drawn and examined for the dynamic conditions of the inland rivers (most of them with similar topology) do not realize their purpose in determining the water biological sufficiency and quality of the Danube. A new set of criteria and standards in accordance with the specific conditions of this large river should be worked out. Further research is necessary concerning current monitoring of water biological sufficiency and quality in several fields. First, indicator parameters of Danubian benthic organisms should be drawn in order to obtain precise and objective data from saprobiological analysis. Second, there is a need for comparative studies on the structural organization of communities, under different conditions of the river bottom, to be carried out in order to arrive at an evaluation of the information value of various biotic indices in accordance with the saprobic dynamics. Third, the selection, testing and standardization of biotic indices for assessment of the water biological sufficiency and quality of the

Danube through zoobenthos should also be undertaken. (Agostine-PTT)
W90-08618

EFFECT OF MERCURY ON THE SURVIVAL OF DAPHNIA MAGNA.
Sarajevo Univ. (Yugoslavia). Inst. for Water Resources Development.
For primary bibliographic entry see Field 5C.
W90-08637

EVALUATION OF WASTE WATER POLLUTION.
Ljubljana Univ. (Yugoslavia). Faculty of Natural Sciences and Technology.
M. Dular, and J. Zagorc-Koncan.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 247-252, 1990. 9 ref.

Descriptors: *Ecological effects, *Pollutant identification, *Regulations, *Wastewater pollution, *Water pollution effects, *Water quality standards, *Yugoslavia, Permits, Pollution load, Rivers, Suspended solids, Toxicity, Wastewater treatment.

Different methods for the evaluation of wastewater pollution are used throughout the world, the most common being the experimental evaluation method. The methods of establishing the pollution load or toxicity of wastewater are divided into two categories: flat rate (prescribed by legislation) and experimental. The simplest methods of flat rate evaluation are based on payment for the volume of released wastewater, regardless of the type and degree of pollution. The experimental evaluation methods are based primarily on the measurements of flow rate and several fundamental properties of waste water such as suspended organic matter and toxicity. Wastewater pollution in individual Yugoslav republics and autonomous regions is discussed. In Serbia, Vojvodina, Montenegro and Slovenia the flat rate methods are used for determining the pollution level of wastewaters. In 1984, Croatia enacted a law stipulating the experimental method for determining wastewater pollution. Bosnia and Herzegovnia began to use an experimental method in 1975. In 1984 in Slovenia the experimental method of calculating effluent charges was proposed. As the transition from the flat rate calculation of effluent charges to the experimental evaluation is made, it is important to select a method which has been tested in practice and whose economic impact is known. The formula used for calculating effluent charges in Bosnia and Herzegovnia would be suitable for Slovenia, after being modified with respect to the factors relating to thermal pollution (which should be dropped) and to suspended solids. (Agostine-PTT)
W90-08638

AUTOMATIC WARNING STATIONS, RECENT SERIOUS INDUSTRIAL RIVER POLLUTION INCIDENTS, AND PREDICTION MODELS OF POLLUTANTS PROPAGATION-SOME EUROPEAN EXAMPLES.
Compagnie Generale des Eaux, Paris (France).
P. Mousty, J. Morvan, and A. Grimaud.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 259-264, 1990. 5 fig.

Descriptors: *Data acquisition, *Model studies, *Monitoring, *Rhine River, *Warning systems, *Water pollution control, *Water quality control, *Water resources management, Accidents, Drinking water, Seine River, Water quality standards.

The automatic analyzing station located on the Rhine River just downstream of the Basel urban area at Huningue, consists of an alarm station linking the automatic detection of certain important pollution parameters (T.O.C., hydrocarbons, heavy metals, pesticides, etc.), and the resulting alarms, to a working mathematical model of pollutant plume propagation, operating on the river between Basel and Strasbourg. This model is keyed to the real flow conditions of the Rhine, determined by life-size tracing operations (using colored Rhodamine marker). A decisive factor in speeding up the transmission of alarm signals, this system

allows, among other things, optimum management of the valves and locks communicating with the Rhine, in order to avoid the penetration of the pollutants into the ramifications of the hydrographic network feeding the groundwater table in Alsace. The alarm station put into service on the Rhine can look back on 10 years experience in the struggle against accidental pollutants which primarily occurred in the Paris area. There, an important alarm network consisting of eight automatic analyzing stations was set up on the rivers Seine, Marne and Oise to protect the most important drinking water supply of France which provides water to more than 4 million inhabitants. (Author's abstract)
W90-08640

5B. Sources Of Pollution

USER'S GUIDE FOR MODELS OF DREDGED MATERIAL DISPOSAL IN OPEN WATER.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 5E.
W90-07518

MEASUREMENT OF HYDROLOGIC PARAMETERS OF CONFINED DREDGED MATERIAL AT WILMINGTON HARBOR, DELAWARE, CONTAINMENT AREA.
Delaware Univ., Newark. Dept. of Geology.
J. E. Pizzuto, and M. E. Poindexter-Rollings.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A219 766. Price codes: A04 in paper copy, A01 in microfiche. Technical Report D-90-4, February 1990. Final Report. 50p, 14 fig, 4 tab, 14 ref, append.

Descriptors: *Computer models, *Dredging wastes, *Path of pollutants, *Waste disposal, Drying, Evaporation, Hydrologic budget, Mathematical studies, Wilmington Harbor.

A computer model, Primary Consolidation and Desiccation of Dredged Fill (PCDDF), has been developed to predict the settlement of dredged material placed in confined disposal sites. PCDDF, calculates both consolidation settlement and desiccation settlement. It uses a well established theory to predict consolidation and employs an empirical formulation to predict desiccation. No field or laboratory procedures exist for determining values for the empirical desiccation parameters. The study established procedures for quantifying these parameters through a field evaluation program in the US Army Engineer District, Philadelphia. A water budget approach was used to calculate desiccation parameters for the dried crust of the desiccating dredged material at the Wilmington Harbor Containment Area near Wilmington, DE. The evaporation efficiency was a constant value of 0.72, the drainage efficiency was 0.21, the saturation limit was 3.02, the desiccation limit was 2.69, the depth of second-stage drying was 0.20 m, and the percent saturation of the desiccated crust (including cracks) was 0.74. The long-term water budget for the desiccated crust for the entire duration of the study clearly indicates that second-stage drying was largely completed when the study began. Because the study was initiated approximately 1 month after the dredged material was placed, these results suggest that both first-stage and second-stage drying are completed very rapidly at the Wilmington Harbor Containment Area. The procedures utilized in the study at the Wilmington Harbor containment area can be employed at other dredged material disposal sites to determine quantitative values for the empirical desiccation parameters. (Author's abstract)
W90-07519

METHODS OF DETERMINING THE LONG-TERM FATE OF DREDGED MATERIAL FOR AQUATIC DISPOSAL SITES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
M. S. Dortch, L. Z. Hales, J. V. Letter, and W. H. McAnally.
Available from the National Technical Information

Service, Springfield, VA. 22161. Technical Report D-90-1, February 1990. Final Report. 201p, 38 fig, 7 tab, 90 ref, 4 append.

Descriptors: *Dredging wastes, *Fate of pollutants, *Ocean dumping, *Path of pollutants, *Waste disposal, Field tests, Long-term planning, Mathematical analysis, Mathematical models, Mounds, Sediment transport.

To manage an open water dredged material disposal site, it is essential to know the physical capacity of the site (i.e., how much material should be dumped at the site and what the capability is of the material to remain onsite under various environmental conditions of waves and currents). Long-term management of aquatic disposal sites also requires an understanding of how much area the disposal mound encompasses, when the mound encroaches on the site boundaries, how much material leaves the site, and perhaps where the material ultimately goes. A study was conducted to identify methods that can be used to develop information concerning the long-term fate of dredged material disposed at aquatic sites. The methods are broken into two major categories: (1) methods of analysis for mount resuspension and dynamics; and (2) methods of analysis for transport and redeposition of mound material. For each of these two categories, four basic approaches are reviewed: (1) steady-state analytical methods; (2) time-dependent and rate-dependent analytical methods; (3) physical and numerical modeling; and (4) measurements through field and laboratory studies. Other sections of the report are devoted to discussions of physical processes and study recommendations. Additional details of the methods of analysis are provided in four appendices. (Author's abstract)
W90-07521

AQUATIC ECOTOXICOLOGY: FUNDAMENTAL CONCEPTS AND METHODOLOGIES. VOLUME I.
CRC Press, Boca Raton, Florida. 1989. 332p.
Edited by Alain Boudou, and Francis Ribeyre.

Descriptors: *Path of pollutants, *Toxicology, *Water pollution effects, Bioaccumulation, Ecosystems, Geochemistry, Inorganic compounds, Lakes, Model studies, Rivers, Sediment contamination, Trace metals, Water analysis.

Research into ecotoxicology can be classified into three fundamental concerns: abiotic factors which characterize the physicochemistry of environments; biotic factors, relating to biological structures and functions; and contamination factors, which define the modes of pollution of ecosystems. As the bases of ecotoxicology lie in the analysis of the structure and the functioning of natural systems, the first two chapters of this Volume I, Part I, are devoted to a synthesis of the current state of knowledge in relation to two main types of freshwater ecosystems: running water (rivers) and still water (lakes). The main concepts of ecotoxicology are developed in Chapter 3, giving particular emphasis to the mechanisms which bring the transfer of contaminants between the different compartments, and also the effects this produces at each biological integration level. The problems of contaminant quantification, from the collecting of samples to the different dosing methods, are described in Chapter 4, using trace metals and metalloids as examples. The other three chapters in Part II deal with the evolution of pollutants in aquatic biotopes: chemical speciation of trace metals (Chapter 5), adsorption of trace inorganic and organic contaminants by solid particulate matter (Chapter 6), and geochemistry and bioavailability of trace metals in sediments (Chapter 7). The most significant research methodologies currently being developed in aquatic ecotoxicology are presented in Part III. After describing the essential mechanisms of contamination of the hydrosphere and its effects on ecosystems (Chapter 8), three case studies were selected to illustrate particular features of field research, the methodologies used and the type of results produced (Chapters 9.1, 9.2, and 9.3). In an intermediate position between the 'ecosystems' level and laboratory models are enclosures and artificial streams, which are presented in Chapter

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10.1, 10.2, and 11. They offer the possibility of compromise between 'representativity', owing to their situation in a natural environment, and 'simplicity', as they are limited to a certain extent and offer the possibility of intervention. (See W90-07523 thru W90-07537) (Lantz-PTT)
W90-07522

SPECIAL FEATURES OF LAKE ECOSYSTEMS.
Toulouse-3 Univ. (France). Lab. d'Hydrobiologie.
For primary bibliographic entry see Field 2H.
W90-07524

FUNDAMENTAL CONCEPTS IN AQUATIC ECOTOXICOLOGY.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
For primary bibliographic entry see Field 5C.
W90-07525

PROBLEMS AND ANALYTICAL METHODS FOR THE DETERMINATION OF TRACE METALS AND METALLOIDS IN POLLUTED AND NONPOLLUTED FRESHWATER ECOSYSTEMS.
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemie.
For primary bibliographic entry see Field 5A.
W90-07526

CHEMICAL SPECIATION OF TRACE METALS.
Universite de Pau et des Pays de l'Adour (France). Dept. of Chemistry.
M. Astruc.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 97-106, 2 fig, 32 ref.

Descriptors: *Chemical speciation, *Path of pollutants, *Speciation, *Toxicology, *Trace metals, Cadmium, Chemical reactions, Inorganic compounds, Methylation, Model studies, Organic matter, Organometals, Tin.

One of the most crucial advances in the field of aquatic chemistry has been the development of new concepts about the speciation of trace elements in the aquatic environment. The aquatic chemistry of trace elements is ruled by a complex competition of the following elementary processes: (1) homogeneous chemical reactions; and (2) surface reactions involving colloids, particulates, and sediment. The influence of biota is still a very cloudy subject. Excretion in water of powerful ligands by a large variety of living species has been demonstrated several times in the laboratory. In natural conditions, however, this is not so clear, due to both dilution and the extreme complexity of the problem. For some elements biologically mediated methylation (biomethylation) has been documented and may play a dominant role in the overall biogeochemical cycles of these elements and perhaps some others. The simultaneous possible occurrence of all these processes in a defined water makes the speciation problem a very difficult one, more so as the concentrations of interest may be very low. Chemical modeling of waters has been the object of many studies. Recent theoretical efforts have already at least partly overcome these criticisms, but other limitations still remain: (1) these calculations deal with the equilibrium state, rather unlikely in actual situations, and (2) modeling needs a complete set of stoichiometric and thermodynamic data. However, some general conclusions have been obtained from these equilibrium calculations for purely inorganic waters. In oxic fresh waters the metal species most commonly encountered are the free hydrated cation $M(H_2O)$ and weak complexes of high to medium lability with hydroxyl or carbonate ions. In seawater the concentration of chloride ions is so high that chloride complexes are often predominant; their lability is high. Widely differing chemical species of trace elements occur in the aquatic environment. All are able to form inorganic complexes and combine with naturally occurring organic ligands. A few of them have been demonstrated to occur as well as organometallic compounds involving metal-carbon covalent bonds. These organometallics may be industrial products or produced by natural biotic or abiotic methylation. Cadmium and tin are used as examples of these respective classes. (See also W90-07522) (Lantz-PTT)
W90-07527

ADSORPTION OF TRACE INORGANIC AND ORGANIC CONTAMINANTS BY SOLID PARTICULATE MATTER.
Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 107-123, 6 fig, 1 tab, 77 ref.

Descriptors: *Adsorption, *Fate of pollutants, *Inorganic compounds, *Model studies, *Organic pollutants, *Organic wastes, *Path of pollutants, Filtration, Hydrogen ion concentration, Kinetics, Land disposal, Suspended solids.

The toxicity and the rate of transport of contaminants is highly dependent on their physical form. The dissolved fraction of pollutants is usually more harmful to the biota than its counterpart, which is fixed on or trapped within natural solids. Also, dissolved species are often transported much more rapidly than suspended solids. Even though many important questions remain to be answered, it is now sufficiently established that adsorption/desorption phenomena at solid-solution interfaces are significant controls on the fate of contaminants in the hydrosphere. Both chemicals and physical models have been developed to describe the adsorption of trace elements on hydrous oxide surface and both can provide a good fit to experimental data. The surface complexation model is a chemical model which was originally developed through studies of the adsorption of trace-metal cations on solid hydrous surfaces. The model takes into account surface reactions, types of surface sites, pH effects on absorptions and reversibility and kinetics. The constant partition coefficient model may be used to describe the uptake of neutral hydrophobic organic substances by natural solids is only applicable to a limited extent to chemicals which are fully or partially ionized at environmental pH values. These models are useful in exploring the problem of contaminant adsorption in the aquatic environment but are still quite far from being models for full prediction of the effect of adsorption under a variety of conditions. (See also W90-07522) (Lantz-PTT)
W90-07528

GEOCHEMISTRY AND BIOAVAILABILITY OF TRACE METALS IN SEDIMENTS.
Bureau de Recherches Geologiques et Minieres, Orleans (France). Water Resources Dept.
P. G. C. Campbell, and A. Tessier.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 125-148, 1 fig, 4 tab, 105 ref.

Descriptors: *Bioavailability, *Geochemistry, *Path of pollutants, *Sediment contamination, *Toxicology, *Trace metals, Chemical properties, Chemical reactions, Particulate matter.

In recent years the fluxes of many trace metals from terrestrial and atmospheric sources to the aquatic environment have increased. Predicting the impact of particulate trace metal contamination on aquatic organisms is difficult. Many such organisms live in contact with both dissolved and particulate trace metals and can, in principle, obtain trace metals either directly from the water or through ingestion of solid phases. Assessing trace metal availability from the solid phases themselves is often difficult, even in laboratory experiments, due to the tendency of trace metals added in particulate forms to establish solute-solid equilibria. The merits and limitations of the methods presently available for estimating trace metal partitioning in aquatic sediments are reviewed and the importance of partitioning in assessing trace metal bioavailability is illustrated. Emphasis is given to surfi-

cial oxic sediments, i.e., those that are most relevant to benthic organisms. Such organisms are generally exposed to particles from an oxic environment either because they live above the anoxic zone or because they have siphons or tubes extending to the oxic zone of the sediments, i.e., they can create their own oxic microenvironments. (See also W90-07522) (Lantz-PTT)
W90-07529

POLLUTION OF THE HYDROSPHERE BY GLOBAL CONTAMINANTS AND ITS EFFECTS ON AQUATIC ECOSYSTEMS.
Paris-11 Univ., Orsay (France). Lab. de Zoologie et d'Ecologie.
F. Ramade.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 151-183, 15 fig, 7 tab, 112 ref.

Descriptors: *Ecosystems, *Path of pollutants, *Water pollution effects, *Water pollution sources, Air pollution, Aquatic environment, Cycling nutrients, Ecological effects, Oil pollution, Pesticides, Polychlorinated biphenyls, Species diversity.

Freshwater and brackish habitats as well as marine ecosystems are currently polluted by persistent organic compounds (organochlorine pesticides and PCBs for example), oil slicks or chronic hydrocarbon release, and, to a smaller extent, by heavy metals and radioactive wastes. Some atmospheric contaminants through the acid rain phenomenon are impinging more and more severely on freshwater ecosystems of the whole Northern Hemisphere and even on some industrialized areas south of the equator. Not only the direct impact of this chemical pollution on the hydrosphere, but also its effect on the physical nature of the aquatic environment has to be assessed. Pollutants may be listed among the most serious types of contaminants that threaten aquatic ecosystems, for they are widespread, released in sufficient quantities and over a wide-enough area that significant pollution of large ecosystems and even of the whole biosphere, could result. The emission of pollutants into the environment is a complex phenomenon and cannot be limited to the fixed image of a waste pipe spilling out its effluents into a lake. In almost all cases, substances discharged into the environment are going to be carried a very long way from their source. Atmospheric and hydrological circulation systems will then disperse them progressively throughout the biosphere. Relatively little information exists about most aspects of the effects of pesticides on whole ecosystems including species diversity, ecosystem stability, nutrient cycling, energy flow, genetics of organisms, and physical resources. Such a conclusion can be easily extended to the deleterious effects of any pollutant occurring in aquatic ecosystems. Studies on the ecotoxicological impact of xenobiotics on aquatic communities have to be initiated at several organizational levels. Ecotoxicological effects may be divided into two major categories: demoecological and biocenotical. Demoecological effects result from the acute or long-term action of pollutants at population level. These effects will be displayed through immediate or premature death, reduced reproductive success and recruitment, reduced growth, and/or increased losses at juvenile stages. Ultimately, they are reflected in the lower abundance and perturbed distribution of the exposed populations of sensitive species. (See also W90-07522) (Lantz-PTT)
W90-07530

FATE AND BEHAVIOR OF TRACE METALS IN A SHALLOW EUTROPHIC LAKE.
Technische Hogeschool Delft (Netherlands).
W. Salomons.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 185-199, 9 fig, 7 tab, 12 ref.

Descriptors: *Fate of pollutants, *IJsselmeer, *Lakes, *Particulate matter, *Path of pollutants, *Trace metals, Adsorption, Algae, Arsenic, Bioac-

cumulation, Cadmium, Chromium, Copper, Eutrophic lakes, Hydrogen ion concentration, Interstitial water, Lead, Manganese, Nickel, Sedimentation, Sinks, Zinc.

The IJsselmeer is an artificial lake in the Netherlands which was created in 1932 when a former lagoon (Zuiderzee) was shut off from the North Sea . The surface area of the lake has gradually decreased as a consequence of reclamation projects. The IJsselmeer acts as a sink for both particulate and dissolved zinc, copper, chromium, nickel, cadmium, and lead. The processes causing their removal from the incoming river water are settling processes (mainly in the Ketelmeer) of riverborne particulates. Dissolved trace metals (zinc, cadmium, chromium) are removed to a large extent by adsorption processes which occur on mixing of Ketelmeer water with the IJsselmeer in the southern part of the lake. A further removal takes place in the remainder of the lake due to uptake by algae and a further pH increase. The output of As and Mn from the lake is higher than the input. Determination of metal concentrations show that these two metals are highly enriched in the pore waters. Flux calculations show that the pore waters may be a significant source for the As and Mn in the surface waters. The high pH in the lake causes a reprecipitation/adsorption of the released Mn and As on the suspended matter, which subsequently leaves the lake through the sluices in the enclosure dike. The IJsselmeer, with regard to processes, is 'particle-dominated' and the pH-increase induced by algal blooms is a major factor in the removal of trace metals. The changes in dissolved metal levels are reflected in metal uptake by the bivalve Dreissena polymorpha. (See also W90-07522) (Lantz-PTT)
W90-07531

MERCURY IN THE OTTAWA RIVER (CANADA).
National Research Council of Canada, Ottawa (Ontario). Div. of Biological Sciences.
A. Kudo.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 201-217, 6 fig, 5 tab, 37 ref.

Descriptors: *Mercury, *Methylmercury, *Ottawa River, *Path of pollutants, *Pollution load, *Pulp and paper industry, Bioaccumulation, Industrial wastes, Sediment transport, Suspended sediments.

The largest industry in Canada is the pulp and paper industry. Along the Ottawa River there are several pulp and paper factories using trees grown in the vast forest of the drainage area. Every ton of paper produced requires between 200 and 600 tons of fresh water. Therefore, most pulp and paper factories are located along rivers, on lakes, and along the seashore. Mercury has been used in the industry for many decades as anodes for the production of sodium hydroxide and chlorine gas (essential chemicals for the pulp and paper industry), and as slimicide to prevent bacterial growth in the production process. A section of the Ottawa River was selected for a detailed study as a model for the natural aquatic environment. The following conclusions resulted from the field observations and laboratory studies during the 5-year project: (1) most of the Hg (96.7% of total Hg and 97.8% of methylmercury) was in bed sediments. Biomass contained an insignificant portion of Hg (0.2% of total Hg and 1.7% of methylmercury); (2) the amount of Hg existing in the study section was about 23.4 kg of total Hg and about 1.23 kg of methylmercury; (2) suspended sediments (or solids) contributed 58% (982 kg/yr) of all Hg transported downstream. Although water (filtered) had a low Hg concentration (13 nanogm/L), it accounted for 41% (689 kg/yr) of all Hg transported downstream; (3) the role of bed sediment movements on the Hg transport was very small, only 1%, in the study section of the Ottawa River; and (4) methylmercury production and destruction were in equilibrium in sediments without any significant contribution from biological agents (higher aquatic plants, invertebrates, or fish). (See also W90-07522) (Lantz-PTT)
W90-07532

FACTORS AFFECTING SOURCES AND FATE OF PERSISTENT TOXIC ORGANIC CHEMICALS: EXAMPLES FROM THE LAURENTIAN GREAT LAKES.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
R. J. Allan.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 219-248, 16 fig, 11 tab, 56 ref.

Descriptors: *Fate of pollutants, *Great Lakes, *Organic compounds, *Path of pollutants, *Water pollution sources, Air-water interfaces, Bioaccumulation, Chemical properties, Degradation, Limnology, Nutrients, Physicochemical properties, Sediment-water interfaces, Suspended sediments.

The Laurentian Great Lakes are among the largest bodies of fresh water in the world. The major processes which influence the fate of persistent toxic organic chemicals in large lakes are the same as those in small lakes and those defined and quantified by laboratory testing: processes governed by the physicochemical characteristics of the chemicals, namely, solubility, volatility, hydrophobicity, degree of partitioning (into or onto sediment and other particulates), lipophilicity, and resistance to degradation (by hydrolytic, photochemical, and biochemical routes). Other processes are related to the limnological characteristics of the receiving body of water and include suspended particulate concentration and type, sedimentation rates, and bioaccumulation pathways. In the Laurentian Great Lakes, three main limnological characteristics interact to affect the fate of persistent toxic organic chemicals: (1) low suspended sediment loads; (2) long residence times; and (3) low trophic states. This paper gives an overview These controlling factors and processes are reviewed. As they affect the fate of toxic organic chemicals introduced from various sources to the Great Lakes. These processes operate across interfaces between major ecosystem compartments: (1) land-water; (2) air-water; (3) sediment-water; and (4) nutrient-water. The major source of toxic organic chemicals to the Laurentian Great Lakes is from land-based activities, both point and non-point sources. Most of the data on atmospheric loads of chemicals to the lakes is based on analysis of wet precipitation. However, adequate samplers to measure toxic organic chemical inputs in all wet, dry, and gaseous phases have yet to be deployed in a systematic network. The thru important roles for sediments in the fate of persistent chemicals in the Great Lakes are: (1) sorption-desorption; (2) burial; and (3) sedimentation-resuspension. Three major processes at the nutrient level also affect organic chemical fate: (1) sedimentation; (2) degradation; and (3) bioaccumulation/food webs. (See also W90-07522) (Lantz-PTT)
W90-07533

AQUATIC ECOTOXICOLOGY: FUNDAMENTAL CONCEPTS AND METHODOLOGIES. VOLUME II.
CRC Press, Inc., Boca Raton, Florida. 1989. 314p.
Edited by Alain Boudou and Francis Ribeyre.

Descriptors: *Ecotoxicology, *Fate of pollutants, *Laboratory methods, *Path of pollutants, *Toxicity, *Toxicology, *Water pollution effects, Data acquisition, Experimental design, Genetics, Mathematical models, Model studies.

Research into ecotoxicology can be classified into three fundamental concerns: abiotic factors, which characterize the physicochemistry of environments; biotic factors, relating to biological structures and functions; and contamination factors, which define the modes of pollution of ecosystems. The most significant research methodologies currently being developed in aquatic ecotoxicology are presented, specifically experimental approaches in the laboratory. Among the main research methodologies developed in the laboratory (Volume II, Part I), a distinction was made according to the biological supports used: (1) Ecotoxicological models. Their chief objective is to show the effect of interspecific relationships on the transfer of contaminants and their effects: linear transfer models

(experimental trophic chains) and interactive models (experimental ecosystems or microcosms)(Chapters 1.1 and 1.2); and (2) Monospecific approaches. Using 'tools' borrowed from toxicology, physiology, biochemistry, and other sciences, this approach gives access to the fundamental mechanisms of bioaccumulation and the dysfunctions that can be induced at organism, cell, or even molecule level. This approach can also be useful in perfecting toxicological tests to estimate the possible risks from using new molecules, from modifying the environment, etc. (Chapters 2.1 to 2.4). The last chapter of Volume II, Part I, is a presentation of the genetic effects of the contamination of aquatic systems. In Part II, Chapter 4 consists of a comparative analysis of the principal methodologies used in aquatic ecotoxicology, drawing conclusions about the relative merits and limitations of each. Chapter 5 is devoted to mathematical modelling, a synthetic method with which it is possible to describe, and even predict, the fate of contaminants in natural systems. The devising of the different mathematical models is illustrated by examples, accompanied by a critical analysis of their structure and use, and a description of their contribution in the decision making processes (artificial intelligence). (See W90-07522 and W90-07538 thru W90-07547) (Lantz-PTT)
W90-07537

TROPHIC CHAINS AND EXPERIMENTAL ECOSYSTEMS: STUDY OF BIOACCUMULATION AND TRANSFER PROCESSES.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
F. Ribeyre, and A. Boudou.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 3-46, 24 fig, 30 ref.

Descriptors: *Bioaccumulation, *Ecotoxicology, *Experimental design, *Mercury, *Path of pollutants, *Toxicology, *Water pollution effects, Carp, Macrophytes, Mayflies, Model studies, Toxicity.

Ecotoxicology is a recent scientific discipline based on the study of modifications in ecosystems which undergo long-term or short-term disruptions. Research methodologies in the field of ecotoxicology, devised and developed in the laboratory are illustrated using mercury compounds as an example. The first stage of the research program is based on devising and setting up linear transfer models: experimental trophic chains. The work consists of taking into account the three fundamental concerns of ecotoxicology: abiotic factors, biotic factors, and contamination factors. Analysis of the actions and interactions of the factors selected, whether controlled (parameters) or measured, was carried out using factorial experimental designs. To quantify the accumulation of Hg compounds in the main compartments and subcompartments of experimental systems (concentration and content), total Hg was measured in samples taken from the different levels of analysis (water, sediment, organisms, organs). Particular attention is paid to each stage in the development of the methodology, from deciding on the direction of the research to the analysis and interpretation of the results. The development of this research program is based on a process of progressive complexation. During the first phase, which was essentially methodological, a three-compartment experimental system was used--water, natural sediment, and rooted macrophytes--which enabled the consideration of a fairly large number of abiotic and contamination factors (temperature, length of light period and light intensity, pH, mercury chemical forms, contamination sources, and concentrations). The aim was to increase and diversify the biological component of the experimental system in order to analyze the effect of interspecific relations on the processes of bioaccumulation and trophic transfer. Despite this very high degree of reductionism, with regard to the complexity of the ecosystems, when such methodologies are put into action on the laboratory scale and the results interpreted, one should not minimize the difficulties encountered, the limitations on their use and the problems of extrapolat-

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ing the conclusions formulated. (See also W90-07537) (Lantz-PTT)
W90-07538

MATHEMATICAL MODELS FOR PREDICTING THE FATE OF CONTAMINANTS IN FRESHWATER ECOSYSTEMS.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
E. Halfon.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 257-274, 11 fig, 35 ref.

Descriptors: *Ecosystems, *Fate of pollutants, *Lake St Clair, *Mathematical models, *Model studies, Artificial intelligence, Decision making, Detroit River, Expert systems, Management planning, Perchloroethylene.

Mathematical models are usually built for two main purposes, to improve understanding of the problems at hand and to predict the fate of toxic contaminants once they enter the environment. Building models for ecological management is not an easy task. While there is often a plethora of data that is peripheral to the problem, there tends to be a conspicuous lack of really useful data. For example, to model the fate of toxic contaminants in Lake St. Clair, the need is for data collected in lake water during different seasons and under different hydrological conditions; one-time surveys are not enough either from a modeling point of view or from an empirical point of view since they do not provide enough information to lead to a theory of contaminant behavior. In the case of perchloroethylene (PERC) in Lake St. Clair, even if concentration data to compare with model simulations had not been available, the model simulations provided insight in the behavior of PERC in the system. During the field programs of 1984 and 1985, no field measurements of PERC losses through volatilization or sedimentation were performed, thus a verification of the model predictions through a program of field observations or independent estimates of PERC volatilization is essential. This observation is valid for any fate model to be used in the St. Clair-Detroit River System; at present the model is only prognostic and could be used to estimate contaminant pathways. The recognition of model uncertainty was a significant development. The artificial intelligence methods of decision trees, decision tables, and expert systems based on if-then rules can be used to analyze the problem of licensing new contaminants when industry does not provide much chemical information on its properties. Although very large expert systems have been successfully built and used in other fields (for example, avionics in airplanes and medical diagnostic systems), the idea of using an expert system in environmental management is novel and relatively untested. It offers a mechanism that captures and organizes the type of information scientists are accustomed to using. (See also W90-07537) (Lantz-PTT)
W90-07546

METHANOGENESIS AND SULFATE REDUCTION IN TIMBER AND DRAINAGE WATER FROM A GOLD MINE.
National Inst. for Water Research, Congella (South Africa). Natal Regional Lab.
L. D. Abraham, K. Westlake, R. I. Mackie, J. F. Putterill, and A. A. Baecker.
Geomicrobiology Journal GEJODG, Vol. 7, No. 3, p 167-183, 1989. 5 fig, 5 tab, 30 ref.

Descriptors: *Air pollution sources, *Methane bacteria, *Methanogenesis, *Mine drainage, *Sulfates, Bacterial analysis, Drainage water, Gold mining, Model studies.

Biogenesis of methane in the heartwood of diseased trees has been shown, but never in timber in service. Studies were undertaken to establish whether methanogens and sulfate-reducers were present in wooden pit props and drainage water from underground sites in a gold mine. The predominant methanogen in the mine ecosystem was tentatively identified as Methanobacterium bryan-

tii. The sulfate-reducers comprised Desulfovibrio desulfotomaculum antarcticum. Most probable numbers (MPN) of bacteria indicated that 350,000 methanogenic and 7,900 sulfate-reducing bacteria are present per milliliter of stagnant drainage water. MPN values per gram of timber were lower for methanogens but comparable for sulfate-reducers. Laboratory model systems predicted a maximum rate of methanogenesis of 2.3 ml methane per gram of wood per day; however, rates would never attain this value because of nutrient limitations and environmental restrictions. Analysis of gas samples extracted from sealed areas of the gold mine verified the presence of methane. (Author's abstract)
W90-07570

HYDRAULIC CHARACTERISTICS OF MUNICIPAL REFUSE.
Converse Consultants East, Caldwell, NJ.
For primary bibliographic entry see Field 5E.
W90-07594

AGRICULTURAL CHEMICALS AND GROUND WATER QUALITY--ISSUES AND CHALLENGES.
Arizona State Univ., Tempe. Dept. of Geology.
H. Bouwer.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 71-79, Winter 1990. 1 fig, 51 ref.

Descriptors: *Agricultural chemicals, *Agricultural runoff, *Groundwater quality, *Nonpoint pollution sources, *Regulations, Agricultural practices, Groundwater pollution, Legislation, Nitrates, Pesticides, Public policy, Water pollution control.

Anthropogenic agricultural chemicals of concern in groundwater include nitrates and pesticides. Increased legislation and regluation of contaminant leels in groundwater can be expected. Groundwater contamination should be prevented from getting worse, but more research is necessary so as to base regulations on sound criteria. health effects and acceptable risks must be better formulated. more research on chemical movement in the vadose zone is necessary for accurate predictive modeling of pesticide transport to groundwater. Best management practices need to be developed so that farmers will be able to farm profitably while complying with regulations for maximum contaminant levels in underlying groundwater. people from all concerned disciplines, citizens' groups, and policy-makers need to work together to develop realistic regulatory policies and management practices that will effectively protect public health while ensuring a viable and sustainable agriculture. (Author's abstract)
W90-07598

MODELING MANAGEMENT PRACTICE EFFECTS ON PESTICIDE MOVEMENT TO GROUND WATER.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
L. L. Shoemaker, W. L. Magette, and A. Shirmohammadi.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 109-115, Winter 1990. 1 tab, 34 ref.

Descriptors: *Agricultural chemicals, *Groundwater pollution, *Model studies, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Water pollution control, Aeration zone, Farm wastes, GLEAMS model, PRZM model.

Awareness that pollution can be caused by agricultural practices has grown over the last two decades. Originally, concerns about agricultural nonpoint source pollution focused on reducing the impacts of agricultural practices on surface waters, such as eutrophication of lakes and estuaries. The assessment of agricultural impacts on water quality are now being redirected to include both groundwater and surface water. Mathematical models have enhanced the ability of scientists to evaluate these impacts. A variety of public domain models are available that can aid in evaluating the effects of managerial activities on pesticide movement to

groundwater. Chemical Movement in Soil; Groundwater Loading Effects of Agricultural Management Systems (GLEAMS); Leaching Estimation and Chemistry Model-Pesticides; Method of Underground Solute Evaluation, Pesticide Analytical Model; Pesticide Root Zone Model (PRZM); and Seasonal Soil Compartment Model. Unfortunately, none of these models can adequately model the unsaturated zone. PRZM is currently the only model available that can assess management practices for pesticides and route those pesticides to groundwater. However, PRZM is relatively insensitive to surface layer variations as compared to GLEAMS, and therefore cannot simulate as accurately the seasonal variation of management practices. GLEAMS, unfortunately, does not route water and chemicals from the bottom of the root zone to groundwater. Further research to address these deficiencies in both PRZM and GLEAMS would increase the reliability of these models in predicting managerial impacts on the transmission of pesticides to groundwater. (Tappert-PTT)
W90-07602

ASSESSMENT OF PESTICIDES IN UPSTATE NEW YORK GROUND WATER: RESULTS OF A 1985-1987 SAMPLING SURVEY.
New York State Water Resources Research Inst., Ithaca.
M. J. Walker, and K. S. Porter.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 116-126, Winter 1990. 6 fig, 7 tab, 43 ref.

Descriptors: *Agricultural chemicals, *Groundwater pollution, *New York, *Path of pollutants, *Pesticides, Alachlor, Atrazine, Carbaryl, Carbofuran, Cyanizine, Groundwater quality, Metolachlor, Monitoring, Simazine.

The New York State Water Resources Institute at Cornell University undertook a two-year sampling survey of pesticides in groundwater beginning in 1985. The survey focused on areas where combinations of agricultural pesticide use, soil texture, and groundwater occurrence seemed likely to lead to leaching. The sampling survey included samples from four types of sampling points: (1) monitoring wells; (2) existing water supply wells; (3) test holes; and (4) tile drains. The monitoring wells were sampled several times during the project in an attempt to characterize temporal changes in groundwater quality corresponding with seasonal changes in groundwater levels. Pesticides studied for this project were atrazine, alachlor, cyanizine, metolachlor, carbaryl, carbofuran (and a metabolite, 3-hydroxy carbofuran), and simazine. The results of the survey did not reveal the expected levels of pesticides. Pesticide residues were detected in six samples collected at four of the thirty sites tested. The three pesticides detected were atrazine, simazine, and 3-hydroxy carbofuran. One sample had a concentration of atrazine equal to the current federal health advisory for long-term exposure (3 parts per billion). All other detections were between detection limits of the analytical method and the health advisory limit. The lack of detection may be due to the insensitivity of the analytical method and the method of crop rotation noted at the sample sites. (Tappert-PTT)
W90-07603

NATIONAL EVALUATION OF THE LEACHING POTENTIAL OF ALDICARB. PART 2. AN EVALUATION OF GROUND WATER MONITORING DATA.
Environmental Protection Agency, Washington, DC.
M. N. Lorber, S. Z. Cohen, and G. D. DeBuchananne.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 127-141, Winter 1990. 2 tab, 45 ref.

Descriptors: *Aldicarb, *Groundwater pollution, *Leaching, *Monitoring, *Path of pollutants, *Pesticides, Agricultural chemicals, Agricultural runoff, Carbamate pesticides, Groundwater quality, Water pollution sources.

Aldicarb was first found in groundwater in Suffolk County, New York, in the late 1970's. Since then, there has been a substantial amount of monitoring associated with aldicarb use on potatoes nationally and on citrus in Florida. A study to identify areas of the United States where aldicarb is likely to leach into groundwater included the results of 50,000 groundwater samples, of which 32% are positive and 13% exceed the EPA Health Advisory Level of 10 ppb. Positive findings are reported for 61 counties in 19 states, and findings above 10 ppb are reported for 31 counties in 11 states. Monitoring data associated with the use of aldicarb on potatoes in the Northeast and upper Midwest demonstrate the potential for aldicarb to impact groundwater near potato-use sites. In contrast, data for potato-use sites in the Northwest and Florida show negative results. Sampling near cotton use in the South and Southwest showed negative findings, while a small number of positives were found in North Carolina and South Carolina. Limited monitoring associated with peanuts showed generally negative results, with trace positives found in Georgia. Sampling from monitoring wells in the shallow groundwater aquifer beneath and downgradient of citrus sites in Florida showed both a high frequency and a high concentration of aldicarb, with one finding above 1000 ppb and numerous findings above 100 ppb. However, only 2% of over 1200 samples collected from domestic drinking wells located near citrus fields, with histories of aldicarb usage, contained residues of aldicarb and no positives were found in 800 samples from deep public drinking water wells in counties with high citrus acreage and aldicarb usage. (Tappert-PTT)
W90-07604

ACCOUNTING FOR TEMPORAL VARIATIONS IN LARGE-SCALE RETROSPECTIVE STUDIES OF AGRICULTURAL CHEMICALS IN GROUND WATER.
Research Triangle Inst., Research Triangle Park, NC. Hydrogeology Dept.
For primary bibliographic entry see Field 7A.
W90-07605

PESTICIDE CONTAMINATION OF GROUND WATER ARTIFICIALLY RECHARGED BY FARMLAND RUNOFF.
Nebraska Univ., Lincoln. Inst. of Agriculture and Natural Resources.
M. E. Exner.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 147-159, Winter 1990. 5 fig, 3 tab, 14 ref.

Descriptors: *Artificial recharge, *Groundwater pollution, *Path of pollutants, *Pesticides, Agricultural chemicals, Agricultural runoff, Alachlor, Aquifers, Atrazine, Cyanazine, Groundwater quality, Groundwater recharge.

In many western states where withdrawal of groundwater has reduced the quantity of available groundwater, surface water is retained to recharge the aquifer. When the recharge structures are sited in agricultural areas, there is the potential for agrichemicals present in runoff to infiltrate to the underlying aquifer with the recharge water. Atrazine, cyanazine, alachlor, and metolachlor in the surface water of a recharge structure which impounds runoff from row-cropped farmland in Nebraska, are transported with seepage to the shallow groundwater flow system and to the locally confined regional aquifer. All wells in the shallow flow system and in the regional flow system impacted by seepage from the structure had detectable concentrations of at least one of the four pesticides. The detectable concentrations of cyanazine, alachlor, and metolachlor in the flow systems ranged from 0.1 to 0.9 ppb. These concentrations were an order of magnitude lower than those in the surface water. Concentrations in the regional aquifer clustered at the lower end of this concentration range. These three pesticides were not detected in the baseline study of the regional aquifer. Unlike alachlor, cyanazine, and metolachlor, atrazine was always present in the wells impacted by seepage from the recharge structure. In the shallow flow system, concentrations ranged from 0.3

to 8.8 ppb and from 0.1 to 2.5 ppb in the regional aquifer. The average of the detectable atrazine concentrations in the baseline study was 0.04 +/- 0.005 ppb. (Author's abstract)
W90-07606

GROUND WATER MONITORING STUDY FOR PESTICIDES AND NITRATES ASSOCIATED WITH GOLF COURSES ON CAPE COD.
Biospherics, Inc., Beltsville, MD.
S. Z. Cohen, S. Nickerson, R. Maxey, A. Dupuy, and J. A. Senita.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 160-173, Winter 1990. 3 fig, 8 tab, 36 ref.

Descriptors: *Chlordane, *Golf courses, *Groundwater pollution, *Network design, *Nitrates, *Path of pollutants, *Pesticides, Cape Cod, Fertilizers, Massachusetts, Nitrogen, Sampling.

The scientific community began to emphasize the study of nitrates in groundwater as a result of fertilization in the mid to late 1970s. By the mid 1980s, tens of thousands of wells were found to contain elevated nitrate concentrations and detectable concentrations of pesticides. Few, if any, of the data were collected from wells associated with the nations's 13,000 golf courses. Pesticides and fertilizers are applied to golf courses, often at high rates, on greens and tees. Several governmental agencies and golf course superintendents on Cape Cod collaborated on a study of the impact of golf course turf management on groundwater quality. Nineteen monitoring wells were installed upgradient and in greens, tees, and fairways on four golf courses. Selected soil core samples were collected and analyzed. Four to six rounds of groundwater samples were collected over one and a half years and analyzed for 17 pesticides and related chemicals; nitrate-N samples were collected at least monthly. Seven of the 17 chemicals were never detected. The most frequently detected chemical--dichlorobenzoic acid--probably had been an impurity in herbicide formulations. Chlordane was detected in several wells at concentrations exceeding the health advisory level, perhaps due either to repeated heavy applications coupled with preferential flow of the bound/particulate phase and/or cross contamination during well installation. The results show no cause for concern about use of these currently registered pesticides. Nitrate-N concentrations were generally below the 10 ppm federal maximum contaminant level, with some exceptions. Overall, nitrate-N concentrations decreased in response to lower application rates and the use of slow-release fertilizer formulations. (Author's abstract)
W90-07607

ASSESSMENT OF GROUNDWATER CONTAMINATION RESULTING FROM A MAJOR ACCIDENT IN LAND NUCLEAR POWER PLANTS (LNPP), I: CONCEPTS AND METHODOLOGY.
TAHAL-Water Planning for Israel Ltd., Tel-Aviv.
A. Mercado.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 1, p 33-41, December 1989. 2 tab, 7 ref.

Descriptors: *Groundwater pollution, *Nuclear accidents, *Nuclear powerplants, *Radioactive wastes, *Water pollution sources, Dispersion, Nuclear engineering, Nuclear reactors, Path of pollutants, Radioisotopes.

Major accidents in Land Nuclear Power Plants (LNPP) resulting in the release of fission products into aquifers and streams are considered to be of extremely low probability. Nevertheless, hydrological site suitability for the construction of an LNPP needs to be examined on the basis of potential groundwater contamination associated with major hypothetical accidents of reasonable probability. The protection of groundwater resources from accidental radioactive releases is based upon the combination of several complementary barriers, including engineering features, geohydrological parameters, and remedial action plans. Loss of Coolant Accident is considered here as the Maximum Design Basis Event in nuclear power plants.

Two alternative nuclide paths, resulting in groundwater contamination are considered:(a) core penetration through the basement, bringing possibly a major part of the nuclide inventory of the reactor into direct contact with underlying groundwaters; or alternatively (b) major nuclide releases to the atmosphere, resulting in their wide spread as fallout, endangering the exploitability of underlying aquifers over large areas. These are referred to commonly as point-source and diffused-source contamination. Contamination analyses, related to the point-source scenario, are derived according to known analytical solutions of the convection-dispersion differential equation for absorbable and decaying species. Processes of concern include the downstream distribution of released nuclide concentration, breakthrough curves at a given stationary point, definition of the extent of the contaminated area, and pollution duration at a given point. (See also W90-07617) (Tappert-PTT)
W90-07616

ASSESSMENT OF GROUNDWATER CONTAMINATION RESULTING FROM A MAJOR ACCIDENT IN LAND NUCLEAR POWER PLANTS (LNPP), II: EVALUATION OF A MELT-THROUGH EVENT.
TAHAL-Water Planning for Israel Ltd., Tel-Aviv.
A. Mercado.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 1, p 43-66, December 1989. 12 fig, 4 tab, 16 ref.

Descriptors: *Groundwater pollution, *Nuclear accidents, *Nuclear powerplants, *Path of pollutants, *Radioactive wastes, Antimony radioisotopes, Convection, Iodine radioisotopes, Nuclear engineering, Nuclear reactors, Plutonium radioisotopes, Radioisotopes, Rubidium radioisotopes, Strontium radioisotopes, Tritium.

Contamination assessment methodology for a point-source scenario is presented for calcareous sand and sandstone aquifers. Contamination predictions were derived according to two major approaches:(a) conservative, associated commonly with risk analyses, where parameter values are chosen to yield reasonably maximum predictions; and (b) a probabilistic presentation of contamination hazards, providing the basis for making decisions according to a given acceptable risk level. Simulated contamination patterns indicate that H3 (tritium) and I129, both presumably geochemically inert species, have the largest downstream pollution range; they are followed by Sr90, Sb125, Ru106 and Pu238, whose magnitude of interaction with aquifer rocks under field conditions is still poorly documented. Since the overall hazard range is dictated in this case by geochemically inert species, this information gap seems to be here of secondary importance. Sensitivity analyses of computed pollution ranges shows relatively low sensitivity to possible variations of nuclides inventory, dispersivity and effective thickness of aquifer formations, and high sensitivity to possible variations of the assumed true downstream velocities of released nuclides. Some possible means to reduce the potential groundwater pollution range of nuclear power plants include recovery operations by pumpage and retainment of Sr near the reactor. (See also W90-07616) (Author's abstract)
W90-07617

EXPERIMENTAL OBSERVATIONS OF MULTIPHASE FLOW IN HETEROGENEOUS POROUS MEDIA.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
B. H. Kueper, W. Abbott, and G. Farquhar.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 1, p 83-95, December 1989. 11 fig, 2 tab, 21 ref. Ontario Ministry of the Environment Grant No. 334PL.

Descriptors: *Groundwater movement, *Heterogeneity, *Multiphase flow, *Organic solvents, *Path of pollutants, *Porous media, Capillary conductivity, Chlorinated hydrocarbons, Porosity, Solvents, Tetrachloroethylene.

Group 5B—Sources Of Pollution

In recent years, contamination of groundwater by dense, non-aqueous phase liquids has become an increasingly common occurrence. Chlorinated solvents are of particular concern; because they are immiscible, surface tension causes the contaminant to be quite sensitive to porous media heterogeneity. A parallel-plate, heterogeneous, sand-pack cell was constructed to study the effects of porous media heterogeneity on the displacement of water by a dense immiscible phase, organic solvent. Tetrachloroethylene-water drainage capillary-pressure–saturation curves were measured for each of four sands used to create various lenses within the cell. The curves were fitted with the Brooks-Corey capillary-pressure–saturation function using a non-linear least-squares fitting routine. Tetrachloroethylene was injected under constant head conditions into the tip of the initially static, water-saturated cell. The tetrachloroethylene behavior in the sand pack illustrated several key features of multiphase flow in heterogeneous porous media and demonstrated the critical role played by the capillary characteristics of the four sands employed. Even small differences in capillary characteristics of the porous media can bring about significant lateral flow of a nonwetting liquid. (Tappert-PTT)
W90-07619

LOADING FUNCTIONS FOR PESTICIDE RUNOFF.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
W. Li, D. E. Merril, and D. A. Haith.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 16-26, January/February 1990. 1 fig, 10 tab, 28 ref.

Descriptors: *Agricultural runoff, *Mathematical models, *Model studies, *Nonpoint pollution sources, *Path of pollutants, *Pesticides, *Regression analysis, *Soil erosion, *Water pollution sources, Agricultural chemicals, Erosion rates, Pollution load, Rainfall-runoff relationships.

Nonpoint pollution from agricultural runoff is a major water quality problem in many regions of the U.S. Pesticide runoff is one of the most serious consequences of the use of agricultural chemicals. Two simple models or loading functions were developed for estimating mean annual pesticide loads in surface runoff. The loading functions are regression equations derived from 100-year simulation runs of a daily pesticide runoff model. Loading functions for nonpoint source pollutants are alternatives to more complex simulation models. The daily pesticide model has separate components for hydrology, soil chemistry, and weather. Input parameters include runoff curve numbers, parameters for the Universal Soil Loss Equation, pesticide half-life and adsorption coefficient, soil bulk density, available water capacity, and mean monthly precipitation and temperature. Conditions were modeled for 12 locations in the eastern U.S. The various combinations of conditions produced a total of 1,920 different cases. Regression Model A explains 71 to 94% of pesticide runoff variations and requires only mean annual soil erosion to estimate pesticide runoff. Model B explains 85 to 96% of pesticide runoff variations and requires both mean annual soil erosion and surface runoff volume during the month of pesticide application. To facilitate applications of the loading functions, half-lives and partition coefficients are provided for 49 pesticides. Mean annual erosivities and monthly runoff are provided for 27 locations in the eastern and central U.S. (Tappert-PTT)
W90-07622

EVALUATION OF VOLATILIZATION BY ORGANIC CHEMICALS RESIDING BELOW THE SOIL SURFACE.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
W. A. Jury, D. Russo, G. Streile, and H. E. Abd.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 13-20, January 1990. 4 fig, 5 tab, 14 ref, 2 append.

Descriptors: *Air pollution, *Mathematical models, *Path of pollutants, *Soil chemistry, *Soil gases, *Vapor pressure, *Volatile organic compounds, *Volatility, Groundwater pollution, Mass transport, Soil surfaces.

Although volatile organic compounds located in buried waste repositories or distributed through the unsaturated soil zone have the potential to migrate to the atmosphere by vapor diffusion, little attention has been paid in the past to estimating the importance of volatilization losses. A screening model used to evaluate the relative volatilization losses of a number of organic compounds under standard soil conditions may provide information important to planning the remediation of hazardous waste sites. The model is an analytic solution to the problem wherein the organic chemical is located at time zero at uniform concentration in a finite layer of soil covered by a layer of soil devoid of chemical. The compound is assumed to move by vapor or liquid diffusion and by mass flow under the influence of steady upward or zero water flow while undergoing first-order degradation and linear equilibrium adsorption. Loss to the atmosphere is governed by vapor diffusion through a stagnant air boundary layer. Calculations were performed on 35 organic compounds in two model soils with properties characteristic of sandy and clayey soil. The model identifies those compounds with high potential for loss during 1 year after incorporation under 100 cm of soil cover and also is used to calculate the minimum soil cover thickness required to reduce volatilization losses to insignificant levels during the lifetime of the compound in the soil. From the latter calculation it was determined that certain compounds e.g. dichlorodifluoromethane may volatilize from deep subsurface locations or even groundwater unless the soil surface is sealed to prevent gas migration. (Author's abstract)
W90-07635

KINETICALLY INFLUENCED TERMS FOR SOLUTE TRANSPORT AFFECTED BY HETEROGENEOUS AND HOMOGENEOUS CLASSICAL REACTIONS.
Geological Survey, Menlo Park, CA.
J. M. Bahr.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 21-34, January 1990. 6 fig, 2 tab, 24 ref, append.

Descriptors: *Groundwater pollution, *Kinetics, *Mathematical models, *Model studies, *Oxidation, *Path of pollutants, *Solute transport, Chemical precipitation, Chemical reactions, Chemical reduction.

Simulation of transport affected by heterogeneous or homogeneous reversible reactions requires a choice between local equilibrium-based and kinetics-based models. The error associated with the use of equilibrium-based models is equivalent to the error of neglecting certain mathematical terms in the governing kinetics-based transport equations. Identification and evaluation of the kinetically influenced terms can therefore aid in the development of criteria for applicability of local equilibrium-based transport models. A four-step derivation procedure, previously presented for cases of transport affected by surface reactions, was applied to transport problems involving homogeneous reactions (solution phase complex formation or oxidation-reduction) and/or precipitation-dissolution reactions. Derivations for these classes of reactions illustrate the manner in which mathematical differences between reaction classes are reflected in the mathematical derivation procedures required to identify kinetically influenced terms. Simulation results for a case of transport affected by a single solution phase complexation reaction and for a case of transport affected by a precipitation-dissolution reaction demonstrate the nature of departures from equilibrium-controlled transport, as well as the use of kinetically influenced terms in determining criteria for the applicability of the local equilibrium assumption. A final derivation for a multireaction problem demonstrates the application of the generalized procedure to a case of transport affected by reactions of several classes. (Author's abstract)
W90-07636

CONTROLLING MECHANISMS FOR STREAM WATER CHEMISTRY AT THE PRISTINE IN-GABEKKEN SITE IN MID-NORWAY: SOME IMPLICATIONS FOR ACIDIFICATION MODELS.
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 2K.
W90-07639

INVESTIGATION OF RADIAL DISPERSION-CAPACITANCE SYSTEM IN POROUS MEDIA.
Phillips Petroleum Co., Bartlesville, OK.
T. F. McCoy, and B. G. Kelkar.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 87-98, January 1990. 13 fig, 3 tab, 20 ref, 3 append.

Descriptors: *Dispersion, *Finite difference methods, *Model studies, *Path of pollutants, *Radioactive tracers, Mathematical models, Numerical analysis, Viscosity.

The lack of radial dispersion experimental work is probably due to the complexity of mathematically representing the radial dispersion equations and the difficulty in experimentally obtaining representative radial concentration profiles. However, dispersion studies in a radial geometry are representative of some real world situations. Experimental and analytical studies were conducted to determine the effect of velocity and viscosity ratio on dispersivity under radial flow conditions. In situ concentration profiles were obtained using technetium 99m (m,metastable) as a tracer in a synthetic core composed of fused aluminum oxide. Early in the study it was noted that capacitance effects due to dead-end pores played a significant role in determining the shape of the experimental concentration profiles. A new mathematical approach that includes capacitance effects in the analytical and numerical solutions was developed for the radial dispersion system. A finite difference numerical model was used in conjunction with a Levenburg-Marquardt minimization routine to analyze the experimental data. Results indicate that dispersivity is independent of velocity for a unit viscosity ratio. In addition, dispersivity was found to be independent of the viscosity ratio for viscosity ratios less than one. (Author's abstract)
W90-07641

CONTAMINANT ACCUMULATION DURING TRANSPORT THROUGH POROUS MEDIA.
Los Alamos National Lab., NM.
J. Gruber.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 99-107, January 1990. 5 fig, 2 tab, 59 ref.

Descriptors: *Adsorption-desorption, *Groundwater pollution, *Model studies, *Oxides, *Path of pollutants, *Pollutants, *Water chemistry, Porous media, Sediment contamination, Soil contamination, Solute transport.

The local processes that operate when a fluid migrates while in contact with a solid can counteract concentration-reducing transport processes such as diffusion or dispersion, and can thus cause accumulation of contaminants. When a soil, rock, or sediment is exposed to changes of its chemical environment by infiltration of water, the new chemical composition propagates as a wave through the medium. Adsorbed contaminants may desorb behind the front of this remobilizing wave. If the velocity of the front is intermediate between the contaminant velocities upstream and downstream of the front, the remobilized contaminant accumulates at the front. The behavior of adsorbates on oxides under these circumstances is of particular interest because their adsorption properties vary strongly with solution composition. The corresponding adsorption model is the surface complexation model. The analysis suggests that contaminant adsorption isotherms are insufficient to characterize the potential hazard associated with a contaminated soil or sediment. The additional data needed are the velocities of the possible remobilizing waves. (Author's abstract)
W90-07642

STOCHASTIC MODELING OF MACRODISPERSION IN HETEROGENEOUS POROUS MEDIA.

California Univ., Berkeley. Dept. of Civil Engineering.
Y. Rubin.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 133-141, January 1990. 7 fig, 39 ref.

Descriptors: *Dispersion, *Mathematical models, *Model studies, *Monte Carlo method, *Path of pollutants, *Solute transport, Groundwater, Porous media, Stochastic models, Tracers.

The physical processes that contribute to the transport of inert solutes are convection, molecular diffusion, and pore-scale dispersion. A stochastic method utilizing 'hard' data was used for the prediction of dispersion processes of inert solutes occurring in heterogeneous porous media. Its main features are as follows: (1) The velocity field is assumed to be a space random function. Its moments are expressed through physical parameters of the log transmissivity and head random fields by linearizing the flow equation. (2) The random velocity, being a linear function of the head and log transmissivity, which are assumed to be jointly multivariate normal (MVN), is thus also MVN. Its probability distribution function (pdf) is completely defined by its first two moments. (3) The derivation of the moments of the velocity pdf is obtained by employing the flow equation. As a result, the employment of this pdf as a random generator ensures a priori the satisfaction of the flow equation. (4) The statistics of the dispersion process are obtained by the particle-tracking method through Monte Carlo simulations which are based on Gaussian conditioning. The method was applied to the Borden natural gradient tracer test with generally good agreement. (Tappert-PTT)
W90-07645

MACRODISPERSION IN SAND-SHALE SEQUENCES.

Geological Survey of Canada, Ottawa (Ontario).
A. J. Desbarats.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 153-163, January 1990. 12 fig, 35 ref.

Descriptors: *Dispersion, *Ficks Law, *Path of pollutants, *Sandstones, *Shales, *Solute transport, Aquifers, Groundwater movement, Groundwater pollution, Mathematical analysis, Model studies, Tracers.

Macrodispersion in sand-shale sequences is investigated by a series of numerical tracer tests. Hydraulic conductivity was modeled as a binary, spatially correlated random function. Realizations of the random conductivity field were simulated on a nodal grid discretizing the heterogeneous formation. Corresponding realizations of the random velocity field were obtained by solving the equation for saturated steady state flow. Particle tracking, with flux-weighted tracer injection and detection, was used to generate experimental residence time distributions (RTDs). Moments of the RTD were used to characterize longitudinal tracer spreading. Results show that macrodispersive transport in sand-shale sequences cannot be represented by a Fickian model. RTDs display a bimodal structure caused by the fast arrival of particles traveling along preferential sandstone channels, and by the much slower arrival of particles following tortuous routes through sandstone and shale. The relative importance of channeling and tortuous flow transport mechanisms is determined by sand-shale conductivity contrast, shale volume fraction, and conductivity spatial correlation structure. Channeling is promoted by high conductivity contrasts, low shale fractions, and flow parallel to bedding in anisotropic media. Low contrasts, high shale fractions, and flow perpendicular to bedding act to break up channels and to enhance tracer spreading. (Tappert-PTT)
W90-07647

FORMATION AND PERSISTENCE OF DNA ADDUCTS IN THE LIVER OF BROWN BULLHEADS EXPOSED TO BENZO(A)PYRENE.

State Univ. of New York Coll. at Buffalo. Great Lakes Lab.
H. C. Sikka, J. P. Rutkowski, C. Kandaswami, S. Kumar, and K. Earley.
Cancer Letters CALEDQ, Vol. 49, No. 1, p 81-87, January 1990. 2 fig, 34 ref. U.S. EPA Grant R-813799 and Cooperative Agreement CR-813840.

Descriptors: *Bioaccumulation, *Bullhead, *Fate of pollutants, *Path of pollutants, Benz(a)pyrene, Benzoates, Fish physiology, Liver, Mutagenicity, Tissue analysis.

The formation and persistence of benzo(a)pyrene-DNA adducts in the liver of brown bullheads (Ictalurus nebulosus) treated with the hydrocarbon (20 mg/kg body weight) was investigated using the 32P-postlabeling assay. The highest level of covalent binding of benzo(a)pyrene to liver DNA was observed 25 to 30 days following treatment. After 70 days, the adduct level in liver DNA had declined to approximately 26% of the maximum adduct level. One major benzo(a)pyrene-DNA adduct and several minor ones were detected in the liver. The major adduct co-chromatographed with anti-benzo(a)pyrene-7,8-diol-9,10-epoxide-deoxyguanosine adduct. The data suggest that brown bullheads metabolically activate benzo(a)pyrene by the same mechanism as the mammalian systems susceptible to carcinogenic effects of the hydrocarbon. (Author's abstract)
W90-07649

IN VITRO EFFECTS OF THREE ORGANO-PHOSPHORUS INSECTICIDES ON KINETIC CONSTANTS OF ACETYLCHOLINESTERASE IN A FRESHWATER TELEOST, CLARIAS BATRACHUS (LINN).

Kakatiya Univ., Warangal (India). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W90-07650

SIMULATION MODELLING OF THE COASTAL WATERS POLLUTION FROM AGRICULTURAL WATERSHED.

Akademiya Nauk Estonskoi SSR, Tallinn. Inst. of Economics.
For primary bibliographic entry see Field 7C.
W90-07652

CHLORIDE LOADING IN THE SOUTH FORK OF THE SHENANDOAH RIVER, VIRGINIA, U.S.A.

James Madison Univ., Harrisonburg, VA. Dept. of Geology and Geography.
W. C. Sherwood.
Environmental Geology and Water Sciences EGWSEI, Vol. 14, No. 2, p 99-106, September/October 1989. 2 fig, 5 tab, 22 ref.

Descriptors: *Chlorides, *Shenandoah River, *Virginia, *Water pollution sources, Deicers, Farm wastes, Fertilizers, Path of pollutants, Pollution load, Salts, Wastewater disposal.

Loading trends and sources of Cl(-) in the South Fork of the Shenandoah River, Virginia were analyzed for the period 1929-1982. Cl(-) has increased from approximately 2 mg/L (2776 tons/yr) to over 10 mg/L (14,256 tons/yr). Natural Cl(-) is estimated to be 1.01 mg/L (1388 tons/yr) with precipitation providing 0.99 mg/L and rocks 0.02 mg/L. From 1929 to 1949 Cl(-) concentration were relatively constant and independent of discharge, indicative of natural or relatively uncontaminated streams. Since 1952 Cl(-) concentrations increased exponentially as river discharges decreased, indicating polluted streams. Since 1965 anthropogenic Cl(-) loading at 12,868 tons/year has remained relatively constant. Four major sources contribute 92.2% (11,871 tons/yr) of the anthropogenic Cl(-): (1) deicing salts--4149 tons/yr, (2) domestic sewage--3015 tons/yr, (3) livestock and poultry wastes--2458 tons/yr, and (4) commercial fertilizers---2249 tons/yr. (Author's abstract)
W90-07656

GRAIN SIZE PARTITIONING OF METALS IN CONTAMINATED, COARSE-GRAINED RIVER

FLOODPLAIN SEDIMENT: CLARK FORK RIVER, MONTANA, U.S.A.

Montana Univ., Missoula. Dept. of Geology.
J. N. Moore, E. J. Brook, and C. Johns.
Environmental Geology and Water Sciences EGWSEI, Vol. 14, No. 2, p 107-115, September/October 1989. 2 fig, 5 tab, 31 ref.

Descriptors: *Clark Fork River, *Metals, *Particle size, *Path of pollutants, *Sediment transport, Flood plains, Montana, River sediments.

The traditional concept of the relationship between metal content and grain size assumes that the fine fraction carries most of the metals in natural sediments. This concept is supported in many cases by strong, significant linear relationships between total-sediment metal concentrations and percentages of various fine-size fractions. Such observations have led to the development of methods to correct for the effects of grain size in order to accurately document geographical and temporal variations and identify trends in metal concentrations away from a particular source. Samples from the floodplain sediment of a large, coarse-grained river system indicates that these concepts do not hold for sediments contaminated by mining and milling wastes. In this particular system, the application of methods to correct for grain-size effects would lead to erroneous conclusions about trends of metals in the drainage. This indicates that the a priori application of grain-size correction factors limits interpretation of actual metal distributions and should not be used unless data indicate that correlations exist between metals and particular size fractions. (Author's abstract)
W90-07657

METAL HOMEOSTASIS AND METALLOTHIONEIN INDUCTION IN RAINBOW TROUT HEPATOCYTES EXPOSED TO CADMIUM.

Quebec Univ., Montreal. Dept. de Chemie.
For primary bibliographic entry see Field 5C.
W90-07659

WATER FLOW PATHS AND HYDROCHEMICAL CONTROLS IN THE BIRKENES CATCHMENT AS INFERRED FROM A RAINSTORM HIGH IN SEASALTS.

Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
For primary bibliographic entry see Field 2A.
W90-07671

COMPARISON OF BIODEGRADATION KINETICS WITH AN INSTANTANEOUS REACTION MODEL FOR GROUNDWATER.

Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
H. S. Rifai, and P. B. Bedient.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 637-645, April 1990. 8 fig, 2 tab, 26 ref, append.

Descriptors: *Biodegradation, *Fate of pollutants, *Groundwater pollution, *Model studies, *Path of pollutants, Comparison studies, Monod kinetics, Organic pollutants, Oxygen transport.

Biodegradation modeling is gaining more attention as a useful tool for predicting the attenuation of organic contaminants in groundwater. Two conceptual models were compared. The first approximates biodegradation with an instantaneous reaction between the organics and oxygen. The advantage of this model is its simplicity and minimal biotransformation data requirements. Inherent in this model is the assumption that biodegradation in groundwater is oxygen transport limited. The second conceptual model utilizes a dual substrate Monod kinetic relationship to calculate biodegradation. While theoretically more accurate, the model suffers from being numerically more complex to implement. The kinetic model also requires more biotransformation data for each organic contaminant than the instantaneous reaction model. The analysis presented is intended to determine the requirements that must be placed on a system's Damkohler number to guarantee that reaction

mechanisms are not kinetically limited. Results indicate that the instantaneous reaction is an adequate assumption when nondimensionalized reaction rates are large. (Author's abstract)
W90-07673

BIOCHEMICAL OXYGEN DEMAND AND ALGAE: FRACTIONATION OF PHYTO-PLANKTON AND NONPHYTOPLANKTON RESPIRATION IN A LARGE RIVER.
Colorado School of Mines, Golden. Dept. of Environmental Sciences and Engineering Ecology.
For primary bibliographic entry see Field 2H.
W90-07675

MULTIYEAR TRENDS IN SNOWPACK ION ACCUMULATION AND LOSS, NORTHERN MICHIGAN.
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
R. Stottlemyer, and D. Rutkowski.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 721-737, April 1990. 14 fig, 4 tab, 34 ref.

Descriptors: *Acid precipitation, *Acid rain, *Chemistry of precipitation, *Michigan, *Snow, *Snowpack, Ammonium, Bicarbonates, Calcium, Hydrogen ion concentration, Ions, Nitrates, Runoff, Seasonal variation, Snowmelt, Sulfates.

From December 1982 to May 1987 the quality and quantity of snowfall and snowpack were measured at four stations in a small (176 ha) gaged watershed adjacent to Lake Superior's south shore. Annual precipitation was less than and winter precipitation greater than that observed east and south of the Lake Superior basin. Snowfall averaged 37% of annual precipitation but was quite variable. Snowfall significantly increased (from 21.1 to 35.7 cm, P < 0.001) with 150 m increase in elevation. Hydrogen and sulfate were the dominant ions in precipitation and snowpack while calcium and bicarbonate dominated stream water. No significant time trends in winter precipitation chemistry were found. Snowpack ionic retention rarely matched precipitation input. Generally, midwinter freeze-thaw periods resulted in elevated concentrations of solutes in snow meltwater and greatly reduced snowpack ion loads prior to peak stream water discharge. All ions exhibited pulses in snowmelt each year. Preferential elution from the snowpack of sulfate and potassium ion was observed. Stream water hydrogen ion, ammonium and most nitrate pulses were associated with midwinter thaws. Stream water sulfate pulses were rare. For those years exhibiting the most pronounced spring increase in stream hydrogen ion, nitrate and sulfate concentration, the magnitude and rate of concentration change was as great in a year of small peak snowpack ion load as it was following a more rapid ion loss from a larger snowpack load. This suggests that the pattern of snowpack melt and especially the pathway the meltwater follows to the stream may be important factors in determining whether stream water chemical pulses occur. (Author's abstract)
W90-07680

ANALYTICAL MODELS OF THE IMPACT OF TWO-PHASE SORPTION ON SUBSURFACE TRANSPORT OF VOLATILE CHEMICALS.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
C. A. Shoemaker, T. B. Culver, L. W. Lion, and M. G. Peterson.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 745-758, April 1990. 10 fig, 1 tab, 36 ref.

Descriptors: *Model studies, *Path of pollutants, *Two-phase sorption, *Volatile organic compounds, Gaseous diffusion, Vapor-phase sorption.

Unsaturated zone models incorporating the impact of vapor-phase sorption on transport of volatile organic compounds are presented with closed form solutions for one-dimensional and two-dimensional cases. In addition to vapor-phase sorption the models incorporate liquid-phase sorption, liquid advection, gaseous diffusion, and volatilization into soil air spaces and to the atmosphere. The motiva-

tion for incorporation of vapor-phase sorption arises from recent experimental results by the authors indicating that vapor-phase sorption may be orders of magnitude higher than liquid-phase sorption under certain soil conditions. The sensitivity analysis suggests that there is considerable interaction among the physical and chemical processes involved in transport of volatile organic compounds. Pollutant concentrations are most affected by the Henry's law constant and gaseous diffusion; the speed of movement of the material depends most upon the pore water velocity and vapor-phase sorption. The incorporation of vapor-phase sorption can significantly reduce model predictions of the transport speed and amount of volatile chemical reaching the groundwater under dry soil conditions. This result is of considerable practical significance since models currently used for remediation and regulation do not include vapor-phase sorption. (Author's abstract)
W90-07682

MINERALIZATION OF SURFACTANTS BY THE MICROBIOTA OF SUBMERGED PLANT DETRITUS.
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
T. W. Federle, and R. M. Ventullo.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 2, p 333-339, February 1990. 4 fig, 1 tab, 15 ref.

Descriptors: *Biodegradation, *Detritus, *Fate of pollutants, *Microorganisms, *Mineralization, *Surfactants, Amino acids, Leaves, Oak trees, Path of pollutants, Sorption, Wetlands.

In wetlands and canopied bodies of water, plant detritus is an important source of carbon and energy. Detrital materials possess a large surface area for sorption of dissolved organics and are colonized by a large and diverse microbiota. To examine the biodegradation of surfactants by these microorganisms, submerged oak leaves were obtained from a laundromat wastewater pond, its overflow, and a pristine control pond. Leaves were cut into disks and incubated in sterile water amended with 50 micrograms of C14-labeled linear alkylbenzene sulfonate (LAS), linear alcohol ethoxylate, stearyltrimethyl ammonium chloride, distearyldimethyl ammonium chloride, benzoic acid, or mixed amino acids per liter. Sorption of the test compounds to the detritus and evolution of (C14)02 were followed with time. All of the compounds sorbed to the detritus to various degrees, with LAS and stearyltrimethyl ammonium chloride the most sorptive, and benzoic acid the least. All compounds were mineralized without a lag. With leaves from the laundromat wastewater pond, half-lives were 12.6 days for LAS, 8.4 days for linear alcohol ethoxylate, 14.2 days for stearyltrimethyl ammonium chloride, 1.0 days for benzoic acid, and 2.7 days for mixed amino acids. Mineralization of LAS and linear alcohol ethoxylate by control pond leaves was slower and exhibited an S-shaped rather than a typical first-order pattern. This study shows that detritus represents a significant site of surfactant removal in detritus-rich systems. (Author's abstract)
W90-07687

SOME OBSERVATIONS ON SEASONAL VARIATION OF RADIO-CESIUM CONTAMINATION IN TROUT (SALMO TRUTTA L.) AND ARCTIC CHAR (SALVELINUS ALPINUS (L.)) IN A NORWEGIAN LAKE AFTER THE CHERNOBYL FALLOUT.
Norges Tekniske Hoegskole, Trondheim.
K. Lonvik, and J. I. Koksvik.
Hydrobiologia HYDRB8, Vol. 190, No. 2, p 121-125, February 1990. 6 fig, 1 tab, 6 ref, append.

Descriptors: *Bioaccumulation, *Cesium radioisotopes, *Char, *Chernobyl, *Fallout, *Nuclear accidents, *Trout, Contamination, Food chains, Lake fisheries, Norway, Path of pollutants, Population exposure, Radiochemical analysis, Seasonal variation.

Radioactive cesium is one of the radioactive components contained in the fallout from the atomic

reactor accident in Chernobyl (April 27 to 28, 1986). It is important to have radioactive contamination in the food chain traced for the actual amount of hazardous radioisotopes Cs137 and Cs134. Radioactive contamination in trout and arctic char from Lake Vekteren in central Norway was measured. From a scintillation gamma-ray spectrum of the dust gathered from the fallout in a nearby city (Trondheim) the amount of radioactive Cs in the air on the day of fallout was estimated as 1.35 kBq/cu m. The corresponding ground deposit was 24.6 kBq/sq m. Fish samples were collected from 110 to 462 days after fallout (August 1986, and March through July 1987). The ratio of the total radioactivity in fish at the beginning of the rise (March; 10,611 Bq/kg) to that of the radioactivity at the end of the summer (August; 9002 Bq/kg), was found to be close to theoretically predicted values. The very strong variation in measured radioactivity during the summer season (high of 25,416 Bq/kg on June 2) is probably only caused by seasonal dietary change. The residence time for biological transfer of Cs in the fish body is estimated to be 1 to 1.5 months. Fallout precipitation in the lake and particle sedimentation seem to be much faster than earlier assumed. (VerNooy-PTT)
W90-07693

ACUTE TOXICITY AND BIOCONCENTRATION OF LINDANE AND DELTAMETHRIN BY RANA TEMPORARIA TADPOLES AND MOSQUITOFISH (GAMBUSIA AFFINIS) (TOXICITE AIGUE ET BIOCONCENTRATION DU LINDANE ET DE LA DELTAMETHRINE PAR LES TETARDS DE RANA TEMPORARIA ET LES GAMBUSIES) (GAMBUSIA AFFINIS).
Paris-11 Univ., Orsay (France). Lab. de Zoologie et d'Ecologie.
For primary bibliographic entry see Field 5C.
W90-07695

FATE OF NITROGENOUS FERTILIZERS APPLIED TO TURFGRASS.
For primary bibliographic entry see Field 5G.
W90-07696

SELENIUM IN THE SOUTHERN COAST RANGE OF CALIFORNIA: WELL WATERS, MAPPED GEOLOGICAL UNITS, AND RELATED ELEMENTS.
San Bernardino County Dept. of Environmental Health Services, CA.
J. E. Tracy, J. D. Oster, and R. J. Beaver.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 46-50, 1990. 2 fig, 3 tab, 17 ref.

Descriptors: *California, *Geohydrology, *Geologic units, *Groundwater pollution, *Groundwater quality, *Selenium, Chemical analysis, Conductivity, Heavy metals, Mountains, Regression analysis, Test wells.

Selenium in subsurface drainage water became a major concern for irrigated agriculture along the western San Joaquin Valley of California when its bioaccumulation in the Kesterson Reservoir resulted in bird deformities and death in 1986. A reconnaissance survey of 151 irrigation and stock wells was conducted in the southern coast range of California bounded by Alameda and San Joaquin counties in the north (37 degrees 45 minutes N) and Ventura and Santa Barbara counties in the south (34 degrees 15 minutes N). Selenium (Se) concentrations in 11 wells exceeded 20 micrograms/L, the recommended water quality guideline for irrigation water. Wells with Se concentrations greater than 2 micrograms/L were associated with nearby surface Pliocene and Miocene (P < 0.001) marine rocks based on Pearson's chi-square analysis. Selenium was linearly related (P < 0.001) to electrical conductivity (EC), sulfate and phosphorus concentrations. Improved regression fits resulted from stratification by Pliocene and Miocene marine surface rocks; stratification also improved the regression fit (P < 0.001) between Se and chlorine. The multiple linear regression equation relating Se to EC and phosphorus within 2.5 km of Pliocene surface rocks produced an R squared of 0.74 and a standard error of estimate of

11 micrograms Se/L. It is concluded that either both Pliocene and Miocene rocks are Se sources, or that Pliocene rocks are positional markers locating recently uplifted, Se-bearing Miocene rocks. Also, surface rock geology and well water composition (EC, P) would be useful information to locate wells that are likely to contain high levels of Se. (Author's abstract)
W90-07697

SULFUR, NITROGEN, AND PH LEVELS IN WISCONSIN PRECIPITATION.
Wisconsin Univ., Madison. Dept. of Soil Science.
T. W. Andraski, and L. G. Bundy.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 60-64, 1990. 4 fig, 3 tab, 34 ref.

Descriptors: *Acid rain, *Chemistry of precipitation, *Nitrogen, *Nutrient transport, *Precipitation, *Sulfur, Air pollution, Crop production, Deposition, Hydrogen ion concentration, Wisconsin.

Precipitation is an important source of sulfur (S) and to a lesser extent nitrogen (N) for agricultural crops and natural ecosystems. Reductions in S and N emissions have occurred and additional revisions in air quality standards will be expected to further reduce the amounts of nutrients such as S and N in precipitation. In order to determine current nutrient deposition rates and precipitation pH levels at 10 sites in important agricultural areas of Wisconsin, bulk precipitation samples were collected at 10-day intervals for a 2-year period from November 1985 to October 1987. Average annual SO4-S deposition was 11 kg S/ha in northwestern Wisconsin and 23 kg S/ha in the south. These S deposition rates are approximately 42% less than the amounts found in a Wisconsin study conducted from 1969 to 1971. Despite this apparent decrease in S deposition, most of the S requirement for crop production is still likely to be provided by S in precipitation in most areas of the state. Annual average NO3-N deposition also differed geographically with 4.2 kg N/ha deposited in the northwest and 8.4 kg N/ha in the south. Average annual NH4-N deposition was 8.7 kg N/ha but showed no geographical trend, and variations among sites were probably influenced by point sources. For most sites, annual deposition amounts of nutrients were similar both years, although concentrations were lower during a year with above-normal precipitation. The annual column-weighted mean pH ranged from 5.1 to 5.9 in a year with a above-normal precipitation and from 3.4 to 4.5 in a year with slightly below-normal precipitation. (Author's abstract)
W90-07700

URANIUM, VANADIUM, AND MOLYBDENUM IN SALINE WATERS OF CALIFORNIA.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 2K.
W90-07703

PLANT UPTAKE OF SLUDGE-BORNE PCBS.
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
G. A. O'Conner, D. Kiehl, G. A. Eiceman, and J. A. Ryan.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 13-118, 1990. 3 fig, 4 tab, 25 ref. US EPA Cooperative Agreement CRS12687-02.

Descriptors: *Bioaccumulation, *Path of pollutants, *Plant tissues, *Polychlorinated biphenyls, *Sludge utilization, Carrots, Contamination, Food chains, Grasses, Hazardous wastes, Lettuce, Soil amendments.

Plant uptake of sludge-borne polychlorinated biphenyls (PCBs; similar to Aroclor 1248) was evaluated in a greenhouse study with two food-chain crops and a grass species. Polychlorinated biphenyl loading to two soils was varied in one experiment by adding different rates of a municipal sewage sludge heavily contaminated (52 mg/kg) with PCBs. In a second experiment, Aroclor 1248 was spiked into unamended soils or soils amended with another sludge containing less than 1 mg/kg PCBs.

Analysis of PCBs was by gas chromatography/mass spectrometry with a reliable detection limit in plants of 20 micrograms/kg for individual chlorinated classes (tri, tetra, and pentachloro biphenyls) and total PCBs. Only carrots (Daucus carota) were contaminated with PCBs, and contamination was restricted to carrot peels. Current US EPA guidelines for land application of sludges based on sludge PCB content are shown to be extremely conservative. (Author's abstract)
W90-07704

RUNOFF OF SULFOMETURON-METHYL AND CYANAZINE FROM SMALL PLOTS: EFFECTS OF FORMULATION AND GRASS COVER.
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Lab.
For primary bibliographic entry see Field 5G.
W90-07705

VOLATILIZATION OF SELENIUM FROM AGRICULTURAL EVAPORATION POND WATER.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
E. T. Thompson-Eagle, and W. T. Frankenberger.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 125-131, 1990. 10 fig, 1 tab, 17 ref. Federal-State San Joaquin Valley Drainage Program Contract 7-FC-20-05110.

Descriptors: *Agricultural water, *Bioremediation, *Evaporation ponds, *Organometals, *Path of pollutants, *Selenium, Amino acids, Biological treatment, Drainage water, Heavy metals, Proteins, Volatility.

A major concern in the San Joaquin Valley, CA, is that high levels of selenium (Se) in agricultural drainage water are concentrating to hazardous levels in evaporation ponds. The primary objective of this study was to determine factors that affect Se biomethylation and thus permanently remove Se directly from evaporation pond water. Pond water samples (14 to 2000 micrograms Se/L) were set up as laboratory mesocosms. The natural formation of dimethylselenide (DMSe) in unamended water was less than 1% of the total Se inventory after 40 days of incubation. No Se methylation took place in autoclaved, unamended pond water. L-Methionine (10 micromolar) stimulated DMSe production in nonsterile pond water, and in autoclaved water (1 micromolar). Increasing the temperature to 35 C and the addition of 1% (weight/weight) glucose with a fungal inoculum, Alternaria alternata, doubled DMSe production over the controls after 25 days of incubation. Carbon sources such as glucose, maltose, sucrose, and galacturonic acid at 2 g carbon/L under ambient conditions slightly enhanced indigenous Se methylation (1.5 fold). Of the amino acids tested, L-methionine (0.02 g carbon/L) stimulated DMSe evolution from pond water more so than L-cysteine, L-cystine, and L-serine. The proteins, egg albumen, casein, and gluten (2 g carbon/L) dramatically increased Se biomethylation causing a 23, 41, and 10% Se loss from the inventory, respectively, after 43 days of incubation. The stimulation of Se volatilization from evaporation pond water through specific amendments could prove to be promising as a field detoxification technique. (Author's abstract)
W90-07706

NITRATE-NITROGEN CONCENTRATIONS IN PERCOLATE FROM LYSIMETERS PLANTED TO A LEGUME-GRASS MIXTURE.
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
L. B. Owens.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 131-135, 1990. 3 fig, 5 tab, 20 ref.

Descriptors: *Groundwater pollution, *Legumes, *Lysimeters, *Nitrates, *Nitrogen, *Nonpoint pollution sources, *Path of pollutants, *Percolating water, Fertilization, Grasses, Leachates, Nitrogen cycle, Nutrient concentrations.

Growing concern that nitrogen (N) from agricultural sources is a major pollutant of groundwater

has stimulated research on nitrate-N (NO3-N) concentrations in groundwater under crops receiving N fertilizer. Knowledge of the effects of legumes on groundwater quality and their potential for reducing NO3-N concentrations is limited. Three Coshocton monolith lysimeters (Y-102A, B, and C) containing a well-drained silt loam soil on a 13% slope, and four lysimeters (Y103A, B, C, and D) containing a moderately well-drained silt loam soil on a 6% slope were used to study the effects of a legume-grass mixture on groundwater quality. Between experiments with corn (Zea mays L.), an alfalfa-orchard grass mix (70% Medicago sativa L. + 30% Dactylis glomerata L.), was grown for 2 years and 3 years on the Y102 and Y103 lysimeters, respectively. The corn, some of which received high rates of N fertilizer, produced NO3-N concentrations in percolate ranging from 15 to 40 mg/L. Under alfalfa, NO3-N concentrations in leachate often were less than 5 mg/L, especially on the moderately well-drained lysimeters. The highest NO3-N percolate concentrations under all treatments occurred during the winter/early spring months. (Author's abstract)
W90-07707

AMERICA'S IRRIGATION: CAN IT LAST.
Agricultural Research Service, Fort Collins, CO.
For primary bibliographic entry see Field 3F.
W90-07711

MODEL OF SURFACE WATER ACIDIFICATION IN CUMBRIA AND ITS USES IN LONG-TERM RESEARCH.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
E. Tipping.
Freshwater Biology FWBLAB, Vol. 23, No. 1, p 7-23, February 1990. 7 fig, 9 tab, 38 ref.

Descriptors: *Acid rain effects, *Acidification, *England, *Hydrologic models, *Model studies, Aluminum, Chemical properties, Cumbria, Deposition patterns, Evapotranspiration, Historical trends, Hydrolysis, Nitrogen, Paleolimnology, Weathering.

A simple process-based model of deposition-catchment interactions in areas of Cumbria, England, underlain by rocks of the Borrowdale Volcanic Series was developed. The processes considered were evapotranspiration, nitrogen uptake by plants, dissolution and precipitation of Al(OH)3, base-cation weathering, hydrolysis of Al3(+), reactions of the carbonate system, and water flow routing. Using estimates of past deposition compositions, past compositions of tarn waters were estimated and indicated declines in pH of up to 1 unit between 1850 and 1950. These changes are similar to those estimated independently from analysis of sediment diatoms. The model also showed that the historical pH trends were consistent with other palaeolimnological evidence that Cumbrian soils have been acid for several thousand years. The model output was also consistent with direct evidence suggesting that the chemical compositions of the Cumbrian tarns have altered little during the past 30 years. The model was used to estimate water compositions during high-flow episodes at various times in the past, and showed that even a small increase in depositional acidity would have made high-flow waters sufficiently acid and aluminum-rich to limit faunal abundance. The model can be used: (1) for prediction, given scenarios for future deposition compositions or catchment behavior; and (2) as a framework for planning future studies and interpreting data. (Author's abstract)
W90-07712

INFLUENCE OF WOODY DEBRIS ON NUTRIENT RETENTION IN CATASTROPHICALLY DISTURBED STREAMS.
Mississippi Univ., University. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-07718

IMPACT OF INTENSIVE CAGE FISH FARMING ON THE PHYTOPLANKTON AND PERI-

Group 5B—Sources Of Pollution

PHYTON OF A SCOTTISH FRESHWATER LOCH.
Stirling Univ. (Scotland). Inst. of Aquaculture.
H. P. Stirling, and T. Dey.
Hydrobiologia HYDRB8, Vol. 190, No. 3, p 193-214, February 15, 1990. 6 fig, 3 tab, 62 ref.

Descriptors: *Algal blooms, *Eutrophic lakes, *Fish farming, *Fish ponds, *Lakes, *Periphyton, *Phytoplankton, *Water pollution sources, Chlorophyta, Cyanophyta, Diatoms, Dissolved oxygen, Eutrophication, Farm wastes, Lake stratification, Monitoring, Nutrients, Temperature.

Nutrients, phytoplankton and periphyton were monitored in a 71 ha shallow, unstratified lake used for intensive cage culture of rainbow trout. Inorganic nitrogen, orthophosphate and suspended solids were significantly higher near the cages and the bottom and, although declining during summer, nutrients did not reach levels which limit phytoplankton growth. Microcystis aeruginosa dominated the phytoplankton, with surface chlorophyll a reaching 189 microg/L in August, but with no subsequent bloom collapse or deoxygenation. A sub-dominant community of 'vernal' diatoms and Pediastrum persisted. Periphyton was dominated by Melosira italica-subarctica. Algal species and water quality showed the lake to be highly eutrophic. Chlorophyll values predicted from a phosphorus-dependent eutrophication model agreed with observations but light limitation by self-shading and suspended farm wastes, aided by wind-induced turbulence, is believed to control algal growth rates and biomass. The environmental management of cage systems in lakes at high production levels is no different from the management of intensive fish ponds. Practical advice includes: monitoring temperature structure for incipient stratification and water color for algal blooms; harvesting as many fish as possible early in summer or at least before any bloom collapses; taking precautions to minimize overfeeding and even withholding rations during critical conditions; and artificial mixing or aeration to maintain turbulence and dissolved oxygen during stratified periods. (Author's abstract)
W90-07719

RATE-LIMITING STEPS IN THE DISSOLUTION OF FLUORITE.
Buenos Aires Univ. (Argentina). Plains Hydrology Inst.
E. J. Usunoff.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/4, p 319-326, January 1990. 4 fig, 2 tab, 17 ref.

Descriptors: *Chemical properties, *Fluorine, *Path of pollutants, *Public health, *Water chemistry, *Weathering, Drinking water, Kinetics, Solute transport.

The study of the behavior of aqueous fluorine species has long concerned hydrologists due to the potential health hazard associated with concentrations in the range of a few milligrams per liter of those species. The need to incorporate kinetic information in hydrochemical studies is demonstrated through column and batch experiments in which fluorite (CaF2) fragments were allowed to dissolve under varying conditions of mean flow velocity and temperature. Results indicate that the dissolution of the mineral would be influenced by the dynamic nature of the system (transport) and by chemical reaction constraints (surface reaction), so establishing a mixed-type of limiting step. The dissolution process is characterized by an activation energy of around 7 kcal/mole. (Author's abstract)
W90-07728

ORGANIC COMPOUNDS DISSOLVED IN WATER BODIES SITUATED IN AN AGRICULTURAL LANDSCAPE AND THEIR ROLE FOR MATTER MIGRATION.
Polish Academy of Sciences, Poznan. Dept. of Agrobiology and Forestry.
For primary bibliographic entry see Field 2H.
W90-07738

IONIC COMPOSITION OF RESERVOIR WATER IN BOHEMIA: LONG-TERM TRENDS AND RELATIONSHIPS.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
For primary bibliographic entry see Field 1A.
W90-07739

NITRATE POLLUTION OF MITIDJA GROUNDWATERS (ALGIERS, ALGERIA).
Universite des Sciences et de la Technologie Houari Boumediene, Algiers (Algeria).
O. Mimouni, and A. Gaid.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 331-337, 1989. 3 fig, 3 tab, 3 ref.

Descriptors: *Algeria, *Groundwater, *Groundwater pollution, *Nitrates, *Nitrogen, *Water pollution sources, Agriculture, Drinking water, Industrial development, Pollutant identification, Urbanization, Water pollution.

In Algeria groundwater is almost the main drinking water resource. An increase of nitrogen concentration in Mitidja groundwater (coastal plain, north of Algeria) was observed. Water wells were sampled in important water-catchments in order to consider a large spatial area and obtain average nitrate concentration in the water. Water was sampled from drilling wells after pumping 10 minutes to avoid superficial water of the aquifer. Nitrogen concentration mainly developed in the center and east of the plain where most important water resources were located. Analyses of different water samples showed that 77.6% had a concentration of N-NO3(-) lower than 11 mg/L and 23.3% had a concentration far over the European standard for drinking water of 11.3 mg/L. The increase was attributed to the developing industrial activities in the area, the spreading intensive agricultural practice and the urbanization of the plain. (Mertz-PTT)
W90-07740

REGULARITIES IN DISTRIBUTION AND MIGRATION FORMS OF HEAVY METALS IN LAKE SEVAN AND ITS TRIBUTARIES.
Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station.
G. H. Babayan.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 345-346, 1989.

Descriptors: *Heavy metals, *Lake sediments, *Lakes, *Path of pollutants, *USSR, *Water pollution, Armenia, Chemical analysis, Cobalt, Copper, Distribution patterns, Eutrophication, Influent streams, Iron, Manganese, Nickel, Reservoirs, Seasonal variation, Trace elements.

In destabilized ecosystems, such as Lake Sevan, in Armenia, USSR, the disturbance of established microelement balance may intensify eutrophication. Lake Sevan was investigated during 1982-1986. Trace metals (copper, nickel, cobalt, iron, and manganese) were analyzed from samples of water and sediment taken at three stations on Sevan and from all the rivers discharging into the lake. Each sample was first filtered through a Sinpor 0.03 mm membrane and then fractionated on a column of Pharmacia Sephadex G-755. Heavy metal analysis was carried out by means of flameless atomic absorption using a Perkin-Elmar 403 spectrometer. The ionic forms of heavy metals were determined by a kinetic chemoluminescent method. Results show that heavy metal concentrations in Sevan are generally low, within the limits observed for other freshwater reservoirs all over the world. Microelement content in the more shallow basin of Major Sevan is higher than that for the minor basin. Concentrations of copper, nickel and cobalt in the lake average twice those in the rivers discharging into Sevan; the total annual yield of studied metals into the lake with its tributaries is about 100 tons. For iron and manganese an inverse regularity is revealed, with upper limits reached in spring and autumn accompanied by increased concentrations for tributaries. Upper concentration limits for the other metals are observed in the summer and autumn periods. Inhomogeneous distribution of heavy metals with depth is linked with water-blooms. (Mertz-PTT)

W90-07742

URBAN NUTRIENT INPUTS AND PHYTOPLANKTON BIOMASS IN A SMALL IMPOUNDMENT ON THE RIVER MURRAY, AUSTRALIA.
Murray-Darling Freshwater Research Centre, Albury (Australia).
T. J. Hillman.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 377-387, 1989. 4 fig, 5 tab, 6 ref.

Descriptors: *Australia, *Eutrophication, *Limiting nutrients, *Murray River, *Phosphorus, *Phytoplankton, *Reservoirs, *Turbidity, *Urban runoff, Biomass, Lake management, Lakes, Water quality.

Lake Mulwala is a small impoundment on the River Murray, Australia, used for water supply and recreation. Earlier studies showed that phosphorus was the nutrient in shortest supply in the lake. Statistical analysis indicated that phytoplankton biomass was usually inversely related to levels of abiogenic turbidity. During periods of low turbidity algal biomass correlated with total-phosphorus concentrations and showed some inverse relationship with water replacement time. It appears that turbidity generally depresses algal growth in Lake Mulwala and that during periods of low turbidity, algal biomass tends to increase to the limit imposed by the availability of phosphorus. Apparently, the addition of phosphorus upstream is not transported inertly in the water column, but is subject to the operation of a buffering by later resuspension. However, the load data indicate that little of the phosphorus is lost to the stream system in the long-term. (Mertz-PTT)
W90-07747

RECOVERY OF HEPATITIS A VIRUS FROM A WATER SUPPLY RESPONSIBLE FOR A COMMON SOURCE OUTBREAK OF HEPATITIS A.
Georgia Dept. of Human Resources, Atlanta. Office of Epidemiology.
A. B. Bloch, S. L. Stramer, J. D. Smith, H. S. Margolis, and H. A. Fields.
American Journal of Public Health AJHEAA, Vol. 80, No. 4, p 428-430, April 1990. 2 fig, 1 tab, 17 ref.

Descriptors: *Filtration, *Groundwater pollution, *Hepatitis A, *Viruses, *Wells, Epidemiology, Microbiological studies, Pollutant identification, Public health.

An outbreak of the picornavirus hepatitis A occurred in a north Georgia trailer park served by a private well. Of 18 residents who were seropositive to hepatitis A 16 (89%) developed hepatitis A. Well water samples were collected 3 months after illness onset in the index case and 28 days after illness onset in the last trailer park resident. Tap water from the trailers was tested for fecal coliform bacteria. Adsorbed viruses were eluted from filter cartridges and the concentrated sample was filter sterilized directly onto a cell monolayer. Hepatitis A virus antigen (HAVAg) was detected in the samples by enzyme immunoassay from three of the five cell lines following two 30-day passages, and from a fourth cell line following a third passage of 21 days. While the incidence of HAV infection has been decreasing in the United States over the past ten years, it continues to be the second leading cause of viral hepatitis. Well water contamination continues to occur and this source of infection is not widely appreciated. (Author's abstract)
W90-07817

SOOT IN THE ATMOSPHERE AND SNOW SURFACE OF ANTARCTICA.
Washington Univ., Seattle. Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 2C.
W90-07826

EFFECTS OF LIMESTONE QUARRYING AND CEMENT-PLANT OPERATIONS ON RUNOFF AND SEDIMENT YIELDS IN THE UPPER PERMANENTE CREEK BASIN, SANTA CLARA COUNTY, CALIFORNIA.
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 4C.
W90-07841

MEASUREMENT OF REAERATION COEFFICIENTS FOR SELECTED FLORIDA STREAMS.
Geological Survey, Orlando, FL. Water Resources Div.
P. S. Hampson, and J. E. Coffin.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4020, 1989. 49 fig, 3 tab. Project no. FL381.

Descriptors: *Aeration, *Dissolved oxygen, *Florida, *Reaeration, *Tracers, *Water quality, Dilution-dispersion, Path of pollutants.

A total of 29 separate reaeration coefficient determinations was performed on 27 subreaches of 12 selected Florida streams between October 1981 and May 1985. Measurements performed prior to June 1984 used the peak and area methods with ethylene and propane as the tracer gases. Later measurements used the steady-state method with propane as the only tracer gas. The reaeration coefficients ranged from 1.07 to 45.9 with a mean estimated probable error of 16.7%. Ten predictive equations also were evaluated using the measured coefficients. The most accurate equation was one of the energy dissipation type with a standard error of 60.3%. Seven additional equations were developed from the measured coefficients using nonlinear regression. The most accurate of the developed equations also was of the energy dissipation form and had a standard error of 54.9%. For 5 of the 13 subreaches in which both ethylene and propane were used, the ethylene data resulted in substantially larger reaeration coefficient values which were rejected. In these reaches, ethylene concentrations probably were significantly affected by one or more electrophilic addition reactions known to occur in aqueous media. (USGS)
W90-07849

PHYSICAL AND CHEMICAL DATA FROM TWO WATER-QUALITY SURVEYS OF STREAMS IN THE LEWISVILLE LAKE WATERSHED, NORTH-CENTRAL TEXAS, 1984 AND 1985.
Geological Survey, Austin, TX. Water Resources Div.
W. S. Gail.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-258, 1989. 2 sheets, 6 fig, 3 tab, 6 ref.

Descriptors: *Lewisville Lake, *Maps, *Nonpoint pollution sources, *Texas, *Water pollution sources, *Water quality, Nitrogen, Nutrient inflow, Phosphorus load.

Twenty-nine sites on streams flowing to Lewisville Lake in north-central Texas were sampled in each of two synoptic (same day) water-quality surveys. The first survey was performed in March 1984 under relatively low-flow conditions and the second was performed in March 1985 under somewhat higher flow conditions. Data are presented for instantaneous measurements of discharge, specific conductance, pH, water temperature, dissolved oxygen, total organic carbon, nitrite-plus-nitrate nitrogen, ammonium-plus-organic nitrogen, total nitrogen, and total phosphorus. Area-based instantaneous yields for discharge, total nitrogen, and total phosphorus were calculated and are displayed graphically showing the rank of each site and the areal distribution of ranks. (USGS)
W90-07850

GROUND-WATER CONTAMINATION AT AN INACTIVE COAL AND OIL GASIFICATION PLANT SITE, GAS WORKS PARK, SEATTLE, WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
G. L. Turney, and D. F. Goerlitz.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4224, 1989. 31p, 7 fig, 6 tab, 25 ref.

Descriptors: *Coal gasification, *Gas Works Park, *Groundwater pollution, *Organic compounds, *Seattle, *Washington, *Water pollution sources, Polycyclic aromatic hydrocarbons, Volatile compounds.

Gas Works Park is located in Seattle, WA on the site of a coal and oil gasification plant that ceased operation in 1956. During operation, many types of wastes, including coal, tar, and oil, accumulated on site. The soil at the park presently (1986) is contaminated with compounds such as polynuclear aromatic hydrocarbons, volatile organic compounds, trace metals, and cyanide. Analyses of water samples from a network of observation wells in the park indicate that these compounds also are present in the groundwater. Polynuclear aromatic hydrocarbons and volatile organic compounds were identified in water samples in concentrations as large as 200 mg/L. Concentrations of organic compound were largest where groundwater was in contact with a nonaqueous phase liquid in the soil, and were lowest where nonaqueous phase liquids were absent, even if the groundwater was in contact with contaminated soils. This condition results from weathering processes at the site, in which soluble, volatile, low-molecular-weight organic compounds are preferentially dissolved from the nonaqueous phase liquid into the groundwater. Where nonaqueous phase liquids are absent, only stained soils containing relatively insoluble, high-molecular-weight compounds remain; therefore organic compound concentrations in the groundwater are much lower. Specific conductance values in water samples were as large as 5,280 microsiemens/centimeter, well above a background of 242 microsiemens/centimeter; this indicates the presence of large concentrations of minerals in the groundwater. Trace metal concentrations, however, generally were less than 0.010 mg/L. Cyanide was present in groundwater samples collected from throughout the park, ranging in concentration from 0.01 to 8.6 mg/L. (USGS)
W90-07861

SUMMARY OF DATA PERTAINING TO LAND USE, RAINFALL, DRYFALL, STREAM DISCHARGE, AND STORM RUNOFF COLLECTED AS PART OF A STUDY OF THE EFFECTS OF URBAN RUNOFF ON RAPID CREEK, RAPID CITY AREA, SOUTH DAKOTA.
Geological Survey, Rapid City, SD. Water Resources Div.
K. E. Goddard, T. K. Lockner, L. L. Harms, and M. H. Smith.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 87-45, 1989. 194p, 40 fig, 22 tab, 16 ref.

Descriptors: *Rainfall-runoff relationships, *Rapid City, *South Dakota, *Urban runoff, *Water quality, Streamflow, Urban hydrology.

The objectives of a 3-year study of urban runoff in the Rapid City area of South Dakota were to characterize the effects of urban runoff from rainfall on the water quality of Rapid Creek, and to evaluate the effects of the runoff on the existing cold-water fishery. In order to meet these objectives, it was necessary to obtain detailed data pertaining to land use, rainfall, dryfall, stream discharge, and storm runoff. This report describes the rationale behind the data collection program, describes the methods used to collect and analyze the data, and presents the data collected and summarized during the study. Six watersheds were investigated, ranging in size from 1,610 to 20,990 acres. Water quality data from 6 sites for about 30 rainstorms that occurred between June 1980 and July 1982 are presented. (USGS)
W90-07862

DIE-AWAY KINETIC ANALYSIS OF THE CAPACITY OF EPILITHIC AND PLANKTONIC BACTERIA FROM CLEAN AND POLLUTED RIVER WATER TO BIODEGRADE SODIUM DODECYL SULFATE.
University Coll., Cardiff (Wales). Dept. of Biochemistry.
D. J. Anderson, M. J. Day, N. J. Russell, and G. F. White.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 3, p 758-763, March 1990. 4 fig, 3 tab, 21 ref.

Descriptors: *Aquatic bacteria, *Biodegradation, *Detergents, *Fate of pollutants, *Kinetics, *Path of pollutants, *Sodium dodecyl sulfate, Microbiological studies, Regression analysis, Surfactants.

The capacities of epilithic and planktonic river bacterial populations to degrade sodium dodecyl sulfate (SDS) in samples taken at two times during 1987 from one clean and four polluted sites in a South Wales river, were estimated in die-away tests under simulated environmental conditions. There was a relatively slow disappearance of SDS in die-away tests for both planktonic and epilithic populations taken from the clean source site, as compared with those taken from the downstream polluted sites, for which the rate of biodegradation was accelerated, sometimes after an apparent initial lag period. The kinetic components contributing to the die-away curves were quantified by nonlinear regression analysis in which the experimental data were fitted to a variety of possible kinetic models. All samples except for one from the polluted sites, best fitted a model which describes the biodegradation of SDS at concentrations well below its half-saturation constant by bacteria whose growth is exponential and unaffected by the addition of a test substrate. Each sample from the clean source fitted a different model, but there was generally little or no growth on endogenous carbon. A consideration of the numerical values of constants derived from the modeling of epilithic and planktonic populations from polluted sites indicates clearly that the biodegradative capacity of epilithic bacterial populations toward SDS is more stable than that of planktonic bacterial populations. (Author's abstract)
W90-07868

TISSUE DISTRIBUTION OF A COLIPHAGE AND ESCHERICHIA COLI IN MUSSELS AFTER CONTAMINATION AND DEPURATION.
University Coll., Cork (Ireland). Virology Unit.
U. F. Power, and J. K. Collins.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 3, p 803-807, March 1990. 2 fig, 2 tab, 21 ref.

Descriptors: *Bacteriophage, *Bioaccumulation, *Depuration, *Escherichia coli, *Fecal coliforms, *Mussels, *Path of pollutants, Biological studies, Mytilus, Tissue analysis.

Experiments were undertaken to determine the tissue distribution of Escherichia coli and a coliphage after contamination of the common mussel (Mytilus edulis). Mussels were contaminated with high levels of feces-associated E. coli and a 22-nm icosahedral coliphage over a 2-day period in a flowing-seawater facility. After contamination, individual tissues were carefully dissected and assayed for E. coli and the coliphage. Contaminated mussels were also analyzed to determine the tissue distribution of the contaminants after 24-h and 48-h depuration periods. The majority of each contaminant was located in the digestive tract (94% of E. coli and 89% of coliphage). Decreasing concentrations were found in the gills and labial palps, foot and muscles, mantle lobes, and hemolymph. The results indicate that contamination above levels in water occurred only in the digestive tract. Contaminated mussels were depurated in a commercial-scale recirculating UV depuration system over a 48-h period. The percent reductions of E. coli occurred in the following order: digestive tract, hemolymph, foot and muscles, mantle lobes, and gills and labial palps. The percent reductions of the coliphage were different, occurring in the follow-

ing order: hemolymph, foot and muscles, gills and labial palps, mantle lobes, and digestive tract. The results clearly demonstrate that E. coli and the coliphages are differentially eliminated from the digestive tract. The two microorganisms are eliminated at similar rates from the remaining tissues. The results also show that the most significant coliphage retention after depuration for 48 h is in the digestive tract. Thus, conventional depuration practices are inappropriate for efficient virus elimination from mussels. (Author's abstract)
W90-07870

INTERACTION OF METALS AND PROTONS WITH ALGAE: II. ION EXCHANGE IN ADSORPTION AND METAL DISPLACEMENT BY PROTONS.
Messiah Coll., Grantham, PA.
For primary bibliographic entry see Field 5D.
W90-07884

CONCENTRATIONS AND FLUXES OF POLYCYCLIC AROMATIC HYDROCARBONS AND POLYCHLORINATED BIPHENYLS ACROSS THE AIR-WATER INTERFACE OF LAKE SUPERIOR.
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
J. E. Baker, and S. J. Eisenreich.
Environmental Science and Technology ESTHAG, Vol. 24, No. 3, p 342-352, March 1990. 12 fig, 7 tab, 64 ref. NOAA Grant NA-85-AA-D-SG136.

Descriptors: *Air-water interfaces, *Lake Superior, *Path of pollutants, *Polychlorinated biphenyls, *Polycyclic aromatic hydrocarbons, Aromatic compounds, Fluctuations, Hydrocarbons, Spatial distribution, Surface water, Volatility.

Concentrations of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) were measured in the atmosphere and surface waters of Lake Superior to estimate the direction and magnitude of their fluxes across the air-water interface. Atmospheric PAH concentrations (total PAH concentrations = 3.8 + or -1.7 mg/cu m, for 13 PAHs) were typical of levels found in continental background air. Atmospheric PCB concentrations (x = 1.2 nanograms/cu m) have remained relatively constant over the Great Lakes during the past 10 years despite lower PCB loadings. PCB congener fugacity gradients suggest PCB volatilization from Lake Superior's surface waters in August 1986. Mean volatilization fluxes of total PCBs (19 nanograms/sq m/day) are similar to estimates of gross atmospheric deposition to the lake, supporting the hypothesis of nonequilibrium, steady-state PCB exchange across the air-water interface. PAH fluxes could not be calculated due to uncertainties in PAH Henry's law constants. (Author's abstract)
W90-07885

ASSESSMENT OF FECAL STEROLS AND KETONES AS INDICATORS OF URBAN SEWAGE INPUTS TO COASTAL WATERS.
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
For primary bibliographic entry see Field 5A.
W90-07886

FLUORITE IN RECENT SEDIMENTS AS A TRAP OF TRACE METAL CONTAMINANTS IN AN ESTUARINE ENVIRONMENT.
Israel Oceanographic and Limnological Research Ltd., Haifa.
B. S. Krumgalz, G. Fainshtein, L. Gorfunkel, and Y. Nathan.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 1, p 1-15, January 1990. 1 fig, 7 tab, 54 ref.

Descriptors: *Cadmium, *Copper, *Estuaries, *Fluorites, *Iron, *Lead, *Mercury, *Path of pollutants, *River sediments, *Trace metals, *Zinc, Dissolved solids, Fluvial sediments, Israel, Kishon River, Organic matter, Particulate matter, Sediment contamination, Sediment transport.

The trace metal contamination of estuarine sediments of the Kishon River, running through a large industrial zone of Israel, was studied. The sediments were analyzed for trace metal (copper, cadmium, iron, lead, mercury and zinc) contents, organic matter content, mineralogical composition and carbonate content. Significant intercorrelations between cadmium, copper, zinc, iron, carbonate content and fluorite (CaF2) content were observed for Kishon River sediments. The Kishon River estuary acts as an efficient trap for anthropogenic trace metals, probably through fluorite precipitation. The important processes for the movement of trace metals from the Kishon river to Haifa Bay appear to be the horizontal transport of contaminated fine grained particles along the river bottom, and transport of trace metals in soluble forms. The trace metal content in Kishon River sediments has considerably increased during the last 14 years. (Author's abstract)
W90-07887

METAL CONCENTRATIONS IN TISSUES OF SPARTINA ALTERNIFLORA (LOISEL.) AND SEDIMENTS OF GEORGIA SALT MARSHES.
Georgia Univ., Sapelo Island. Marine Inst.
J. J. Alberts, M. T. Price, and M. Kania.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 1, p 47-58, January 1990. 4 fig, 2 tab, 15 ref. NOAA Office of Sea Grant, Department of Commerce Grant NA84AA-D-00072.

Descriptors: *Marine sediments, *Metals, *Path of pollutants, *Salt marshes, *Wetlands, Absorption, Aluminum, Cadmium, Chromium, Copper, Georgia, Heavy metals, Iron, Manganese, Mercury, Molybdenum, Nickel, Tissue analysis, Vanadium, Water pollution sources, Zinc.

The concentrations of eleven metals (Al, Cd, Cr, Cu, Fe, Hg, Mn, Mo, Ni, V and Zn) were determined in salt marsh sediments from seven locations in two industrial/port cities and one relatively unimpacted region of the Georgia coast. In addition, six of these elements (Al, Cu, Fe, Hg, Mn and Zn) were measured in the above and below-ground tissues of the salt marsh plants Spartina alterniflora from the same locations and in Spartina cynosuroides at one site. The sedimentary metal concentrations of Cr, Cu, Hg, V and Zn were higher in the industrial/port sites by less than a factor of ten relative to the other areas, and the remaining elements had similar sedimentary concentrations at all locations. Tissue concentrations of elements in S. alterniflora varied little between sites. Elemental ratios and concentration factor calculations for plant tissues indicated that Al and Fe were not actively taken up, but that internal concentrations of Cu and Hg appeared to be controlled by the plants. (Author's abstract)
W90-07890

PETROLEUM HYDROCARBONS IN THE SURFACE WATER OF TWO ESTUARIES IN THE SOUTHEASTERN UNITED STATES.
South Carolina Univ., Columbia. Dept. of Chemistry.
T. F. Bidleman, A. A. Castleberry, W. T. Foreman, M. T. Zaranski, and D. W. Wall.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 30, No. 1, p 91-109, January 1990. 9 fig, 5 tab, 42 ref. NOAA Grants CEIP-82-08 and CEIP-83-04.

Descriptors: *Estuaries, *Hydrocarbons, *Oil pollution, *Path of pollutants, *South Carolina, *Surface water, Charleston Harbor, Fluorescence, Gas chromatography, Mass spectrometry, Pollutant identification, Polycyclic aromatic hydrocarbons, Winyah Bay.

Surface water samples from Charleston Harbor and Winyah Bay, South Carolina were analyzed for total hydrocarbons by gas chromatography (GC) and for petroleum residues (expressed as crude oil equivalents) by fluorescence spectrometry (FS). Cleanup by column chromatography and saponification was necessary to reduce the background from extraneous fluorescing materials. Oil concentrations determined by FS ranged from 0.5-25 micrograms/L in Charleston Harbor and <

0.23-9.6 micrograms/L in Winyah Bay. Hydrocarbons determined by GC were significantly correlated (P < 0.0i) with crude oil equivalents determined by FS, but the data showed considerable scatter. Polycyclic aromatic hydrocarbons were determined by gas chromatography-mass spectrometry for one set of Winyah Bay samples. The sum of nonalkylated polycyclic aromatic hydrocarbons having > or = 3 rings ranged from 7-64 nanograms/L at different stations. Perylene, possibly originating from sediment dredging, was one of the more abundant polycyclic aromatic hydrocarbons. (Author's abstract)
W90-07891

OHIO RIVER OIL SPILL: A CASE STUDY.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark, A. H. Vicory, and J. A. Goodrich.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 3, p 39-44, March 1990. 6 fig, 2 tab, 7 ref.

Descriptors: *Monongahela River, *Ohio River, *Oil pollution, *Oil spills, *Path of pollutants, *Water pollution effects, Case studies, Cleanup operations, Water pollution treatment.

On January 2, 1988, a massive spill of 3.8 million gallons of diesel oil on the Monongahela River near Pittsburgh, Pennsylvania illustrated the vulnerability of drinking water utilities to upstream point and nonpoint sources of pollution. The spill breached an earthen barrier surrounding the split storage tank and entered the river through storm sewers. Normal procedures used to control oil spills were only partially successful; 30% of the spilled oil was recovered with brooms and vacuums. The spill also pushed through several locks and dams, causing the diesel oil to mix vertically in the water column. As the slick moved slowly past Pittsburgh, then into the Ohio River, water plants had to close their water intakes. Procedures for spill notification went into effect. The Ohio River Valley Water and Sanitation Commission (OR-SANCO) played a major role in coordinating the dissemination of information and emergency and remedial action. Thirteen laboratory stations operated in cooperation with 11 water utilities and 2 industries to collect daily water samples and analyze them for 16 halogenated compounds. Although the long-term damage from the spill is still not known, diesel oil passing through locks and dams stained concrete walls, caused many communities to use bottled water, and brought commercial activity to a virtual standstill. The Natural Resource Damage Assessment procedure will define the overall extent of the spill. Ashland Oil Inc., the company responsible for the spill, has agreed to a long-term cleanup program and will reimburse the federal government $680,000 in connection with the spill. The spill illustrated the need for better information regarding the time of passage versus discharge levels for various stages of Ohio River flow. Computer models should be developed that can better predict both travel time and concentration of contaminants in the event of future spills. (Geiger-PTT)
W90-07893

ORGANIC CARBON AND THM FORMATION POTENTIAL IN KANSAS GROUNDWATERS.
Kansas Dept. of Health and Environment, Topeka. Bureau of Environmental Remediation.
R. E. Miller, S. J. Randtke, L. R. Hathaway, and J. E. Denne.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 3, p 49-62, March 1990. 6 fig, 11 tab, 11 ref. University of Kansas General Research Fund Allocation 3070-XX-0038.

Descriptors: *Groundwater pollution, *Kansas, *Organic carbon, *Path of pollutants, *Trihalomethanes, Alluvial aquifers, Ammonium, Aquifer characteristics, Chlorinated hydrocarbons, Geochemistry, Groundwater quality, Iron, Manganese, Water pollution control.

Fifty wells in Kansas were sampled to determine the concentrations of total organic carbon (TOC)

and trihalomethane formation potential (THMFP) associated with major aquifer systems. The mean TOC and THMFP concentrations were 1.03 +/- 0.76 mg/L and 46.7 +/-39.5 micrograms/L; THMFP was very strongly correlated with TOC (r=0.953). Only 8% of the THMFP concentrations exceeded 100 micrograms/L, but 56% exceeded 25 micrograms/L and 90% exceeded 10 micrograms/L, suggesting that many Kansas water utilities using groundwater might have difficulty meeting a substantially lower THM standard. THMFPs were higher in alluvial aquifers which naturally contain greater levels of TOC. Only weak correlations were found between THMFP and TOC as a function of depth, chlorine demand and most geochemical constituents. Efforts to control trihalomethanes in Kansas groundwater supplies should focus on alluvial aquifers, particularly those with high concentrations of TOC, ammonium, iron, and manganese. (Author's abstract) W90-07895

RADIUM-226 AND TRITIUM IN PUBLIC WELL SUPPLIES OF THE GREATER CHICAGO AREA.

Metropolitan Water Reclamation District of Greater Chicago, IL. Research and Development Dept.
L. M. Kristoff, D. T. Lordi, and C. Lue-Hing.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 3, p 77-82, March 1990. 3 fig, 5 tab, 13 ref.

Descriptors: *Chicago, *Drinking water, *Groundwater pollution, *Groundwater quality, *Radium radioisotopes, *Tritium, *Water pollution sources, *Wells, Deep wells, Monitoring, Shallow wells, Water quality.

Relatively high levels of total alpha and beta radioactivities encountered in wastewater of one of the wastewater treatment facilities operated by the Metropolitan Water Reclamation District of Greater Chicago prompted a radiological survey of the municipal well water supplies in the region. Grab samples of treated well waters were collected from various water supplies located in Cook County, Illinois, the area served by the reclamation district. A modified method of the procedure involving the precipitation of radium-226 with barium sulfate was used to ensure that all the radium-226 would be collected. Samples were counted with a proportional counter for total alpha and total beta radioactivities. The concentrations of total alpha activity, total beta activity, and radium-226 were found to be higher in waters from wells with depths greater than 1,200 ft (366 m) than in waters from wells of less than 850 ft (259 m) depth. The waters from 10 of the deep wells were found to contain an unmeasurable concentration of tritium, but all of the shallow-well waters contained tritium at 0.3 nCi/L. Some of the deep wells may contain dead waters. The waters coming from the deep wells reflect the conditions of the strata from which they are drawn, primarily the Galesville-Ironton sandstone formation in the Cambrian system. The shallow wells draw their water from the shallow Racine formation of the Devonian and Silurian systems. (Author's abstract) W90-07897

SOME OBSERVATIONS ON NESTED MODELLING OF FLOW AND SOLUTE TRANSPORT IN RECTANGULAR HARBORS.

Birmingham Univ. (England). Dept. of Civil Engineering.
L. Mardapitta-Hadjipandeli, and R. A. Falconer.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 89, No. Part 2, p 15-38, March 1990. 13 fig, 1 tab, 18 ref.

Descriptors: *Harbors, *Mathematical models, *Model studies, *Numerical analysis, *Path of pollutants, *Solute transport, *Water pollution sources, Hydrodynamics, Mathematical studies, Tidal effects, Water circulation.

A non-dynamically linked nested numerical model has been successfully applied to predict the tide induced circulation and solute concentration distributions in physical models of idealized rectangular

harbors. The numerical model results indicated potential scaling problems associated with distorted physical models of recirculating flows; the numerically predicted optimum gross solute exchange coefficient occurred for different aspects ratios at the laboratory and prototype model scales. The nested numerical model results are in good agreement with the laboratory model results, at the same scale, although the disparity between the coarse grid predictions and the laboratory results highlights the significance of the grid size in modeling recirculating flows. (Geiger-PTT) W90-07901

SORPTION OF HYDROPHOBIC COMPOUNDS ON AQUIFER MATERIALS: ANALYSIS METHODS AND THE EFFECT OF ORGANIC CARBON.

Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
L. W. Lion, T. B. Stauffer, and W. G. MacIntyre.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 3, p 215-234, March 1990. 8 fig, 3 tab, 40 ref.

Descriptors: *Groundwater pollution, *Hydrocarbons, *Organic carbon, *Path of pollutants, *Polymers, *Sorption, Partition coefficients, Polynuclear aromatic hydrocarbons, Teflon.

Sorption studies of polynuclear aromatic hydrocarbons (PAH) on low-carbon aquifer materials are reported. Both column and batch partition coefficients were affected by synthetic polymeric components, such as Teflon, in commonly used experimental apparatus. These influences include incorrect (high) estimates for partition coefficients and tailing of peaks in column studies. Both batch and column experimental methods are developed, using polymer-free systems, that allow accurate measurement of partition coefficients for hydrophobic PAHs in low-carbon systems. Application of these methods shows that organic carbon contents below the commonly cited threshold level of 0.1% may dominate the partitioning and subsequent transport of phenanthrene in aquifer systems. (Author's abstract) W90-07903

EFFECT OF PH CONCENTRATION ON THE TRANSPORT OF NAPHTHALENE IN SATURATED AQUIFER MEDIA.

Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
A. T. Kan, and M. B. Tomson.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 3, p 235-251, March 1990. 5 fig, 3 tab, 44 ref.
EPA Assistant Agreement No. CR-812808.

Descriptors: *Groundwater pollution, *Naphthalenes, *Organic pollutants, *Path of pollutants, *Sorption, DDT, Hydrogen ion concentration, Model studies, Soil contamination, Toluene.

Sorption is one of the primary mechanisms for retarding the movement of organic contaminants in groundwater. Sorption of hydrophobic compounds such as toluene, naphthalene, and DDT is generally assumed to be linearly proportional to solution phase concentration. Naphthalene was chosen as a model compound. Batch adsorption was studied from 0.01 to 1.00 mg/L. Transport of naphthalene through a specially designed soil column apparatus was studied from 5 to 9 pH and from 0.025 to 2.0 mg/L initial concentration. All transport data could be modeled using a single pH-modified Freundlich isotherm. The exponent (0.81) is similar to that reported by numerous authors for the fate of contaminants in soil and probably reflects a decrease in the sorption energy with increasing solution concentration. The negative slope of sorption vs pH is consistent with common models of humic structure vs pH, but too little data is available in the literature to test the reasonableness of the numerical value of the slope. (Author's abstract) W90-07904

CHARACTERIZATION OF A SANDY AQUIFER MATERIAL AT THE GRAIN SCALE.

Stanford Univ., CA. Dept. of Civil Engineering.

For primary bibliographic entry see Field 2G. W90-07905

UNSTEADY RADIAL FLOW OF GAS IN THE VADOSE ZONE.

Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
D. B. McWhorter.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 3, p 297-314, March 1990. 8 fig, 2 tab, 21 ref, append.

Descriptors: *Gas permeability, *Groundwater pollution, *Path of pollutants, *Soil water pollution, *Unsaturated flow, *Vadose zone, Density, Mathematical equations, Viscosity.

An exact, quasi-analytic solution for unsteady radial gas flow to injection or withdrawal wells is developed. Nonlinearities stemming from pressure-dependent density, viscosity, and gas permeability are accounted for in the general development. A new pseudo-pressure is defined. Under the conditions of modest mass discharge and small pressure gradients expected to prevail in most hydrologic applications, the rigorous pseudo-pressure is closely approximated by a simple expression that is easily evaluated in terms of the actual gas pressure. The nonlinearity arising from the Klinkenberg effect is shown to be important only for circumstances that result in large pressure gradients such as will occur for large injection or withdrawal rates in media with low permeability. A procedure for determining the apparent gas permeability from test data is demonstrated using a set of simulated data generated from the quasi-analytic solution. (Author's abstract) W90-07906

EXPERIMENTAL STUDIES ON THE SURVIVAL OF FECAL BACTERIAL FROM URBAN SEWAGE IN SEAWATER (ETUDE EXPERIMENTALE DE LA DECROISSANCE DES BACTERIES FECALES EN MILIEU MARIN QUANTIFICATION, FACTEURS IMPLIQUES).

Fondation Oceanographique RICARD, BP 39, 13762 Les Milles Cedex, France.
J. L. Bonnefont, Y. P. Martin, and B. Guiennet.
Water Research WATRAG, Vol. 24, No. 3, p 267-273, March 1990. 5 fig, 3 tab, 19 ref. English summary.

Descriptors: *Coliforms, *Marine pollution, *Path of pollutants, *Wastewater pollution, Bacterial survival, Depth, Seawater, Sunlight.

Numerous studies addressing the disappearance of contaminating fecal bacteria (fecal coliform, fecal streptococci) into the ocean show extremely varied results. Bacterial survival is affected by numerous physical and biological parameters and its study in seawater is hindered by methodological difficulties and the extreme variations in the natural environment. To gain a better understanding of the more influential parameters, experimental models have been established, mixing urban effluents with seawater under specified conditions. Studies done with a system protected from light have determined a disappearance factor, that is, the intrinsic biological death occurring in several dozens of hours. Streptococci survival is better than that of coliforms. Statistical analysis of the data shows that this biological death depends on the richness of nutrients in the initial mixture. In the presence of sunlight disappearance is very quick, on the order of an hour. This effect remains discernible in the ocean up to a depth of at least 8 m. To better simulate a discharge into seawater, an experimental system with continuous flow and an adjustable mixture of seawater and urban effluents has been put into operation. The role of sunlight remains preponderant over other parameters, such as residence time and the bacterial adaptation phenomenon. It follows from this study that the disappearance factor depends on the hour of the sampling and the exposure to sunlight at that time. As a consequence, it would seem hazardous to give estimates of decreasing entero-bacteria concentrations discharged in seawater that would be applicable to different situations. (Author's abstract)

Group 5B—Sources Of Pollution

W90-07907

EVALUATION OF LAND APPLICATION USING SECONDARY EFFLUENT IN A FOREST SLOPE: ESTIMATION OF DRAINED WATER QUALITY AND DISCUSSION OF THE EFFECTS UPON SOIL OR PLANTS AND BEHAVIOR OF BACTERIA.
Kagawa Univ., Takamatsu (Japan).
For primary bibliographic entry see Field 5E.
W90-07908

VERTICAL AND LATERAL DISTRIBUTION OF FINE-GRAINED PARTICULATES IN PRAIRIE AND CORDILLERAN RIVERS: SAMPLING IMPLICATIONS FOR WATER QUALITY PROGRAMS.
National Water Research Inst., Burlington (Ontario).
E. D. Ongley, T. R. Yuzyk, and B. G. Krishnappan.
Water Research WATRAG, Vol. 24, No. 3, p 303-312, March 1990. 5 fig, 5 tab, 26 ref.

Descriptors: *Lateral distribution, *Particulate matter, *River sediments, *Sediment distribution, *Water quality, Clays, Cordilleran rivers, Homogenation, Prairie rivers, Silt, Vertical distribution, Water column characteristics.

The fine sediment fraction, usually <63 micrometers, is generally regarded as significant for water quality issues. This fraction is usually presumed to be evenly distributed in the vertical column. Using period of record data for three prairie rivers and three cordilleran river sites, and midstream data from the Mackenzie River, the degree to which near-surface samples of silt and clay are representative of the vertical and cross section was examined. These data were available only for high flow conditions. Surface samples of silt + clay tended to underestimate the vertical mean concentration by less than 10%; also, 89% of the surface data at five of the six sampled sites were within plus or minus 15% of the vertical mean concentration. The individual vertical distributions of clay and silt displayed inconsistent and variable patterns of concentration with depth and could include large excursions within individual profiles. Large, deep rivers did not behave differently from shallow ones. There was no evidence of increasing homogenization of silt + clay across the section as discharge increased. The data indicated typical errors that may be expected if surface samples are used to characterize the water column at high discharges. (Author's abstract)
W90-07911

IN SITU DETERMINATION OF PCB CONGENER-SPECIFIC FIRST ORDER ABSORPTION/ DESORPTION RATE CONSTANTS USING CHIRONOMUS TENTANS LARVAE (INSECTA: DIPTERA: CHIRONOMIDAE).
New York State Dept. of Environmental Conservation, Albany. Bureau of Water Research.
M. A. Novak, A. A. Reilly, B. Bush, and L. Shane.
Water Research WATRAG, Vol. 24, No. 3, p 321-327, March 1990. 2 fig, 3 tab, 12 ref.

Descriptors: *Bioaccumulation, *Midges, *Path of pollutants, *Polychlorinated biphenyls, Bioassay, Chlorination, Testing procedures.

The uptake of polychlorinated biphenyl (PCB) congeners was measured in the larvae of a laboratory-reared chironomid midge, Chironomus tentans, placed in the upper Hudson River, New York during 2 months in 1985. This procedure was investigated as a method for determining water congener concentrations during times of fluctuating PCB levels, and to model uptake of PCBs by river biota. After a 96 h exposure period, total PCB concentrations in the test organisms averaged 6.7 micrograms/gram total PCBs, compared with water concentrations of 67 ng/L (mean value for both months). Uptake and elimination constants, time to equilibrium and concentration factors were calculated for each of 21 selected congeners. Analysis of PCB congeners in insects harvested at intervals during the 96 h period showed that uptake

differs with varying degrees of chlorination relative to water concentrations. At the end of the exposure period, concentration factors ranged from 4000 to over 300,000 times the water concentrations. Differences in the replicate indicate potential problems with this method as a field tool; instead of using all congeners separated in analysis, several individual congeners should be selected for use based on their importance to the river fauna and the consistency with which they are analyzed. (Author's abstract)
W90-07913

ELIMINATION OF LONG LIVED FISSION PRODUCTS FROM RIVER SEDIMENT.
Novi Sad Univ. (Yugoslavia). Inst. of Physics.
L. Conkic, Z. Skrbic, J. Slivka, M. Veskovic, and I. Bikit.
Water Research WATRAG, Vol. 24, No. 3, p 333-335, March 1990. 3 fig, 1 tab, 8 ref.

Descriptors: *Cesium, *Chernobyl, *Fate of pollutants, *Nuclear accidents, *Path of pollutants, *Radioisotopes, *Ruthenium radioisotopes, Danube River, Elimination rate, Radioactive half-life, Sediment contamination.

The activity concentration of cesium-137, cesium-134 and ruthenium-106 in the sediment of the Danube river was measured for a period of 18 months after the Chernobyl accident. During this interval (June 1986 until December 1987) samples were collected 15 times at Bezdan. From the data fitted with a simple exponential decay function the same value of 'corrected elimination half-life' of about 240 d was derived for all three radionuclides. The most important conclusion is that the elimination rate of the long lived isotopes, e.g. cesium-137, from the river sediment is much faster than one can predict from the radioactive decay, at least within 2 years after sudden contamination. It is clear, however, that the derived value for corrected elimination half-life is strongly influenced by the local hydrological and meteorological conditions during the period of measurement. (Author's abstract)
W90-07915

AVAILABILITY OF SORBED TOLUENE IN SOILS FOR BIODEGRADATION BY ACCLIMATED BACTERIA.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
K. G. Robinson, W. S. Farmer, and J. T. Novak.
Water Research WATRAG, Vol. 24, No. 3, p 345-350, March 1990. 9 fig, 1 tab, 22 ref.

Descriptors: *Biodegradation, *Cleanup, *Fate of pollutants, *Path of pollutants, *Soil bacteria, *Soil contamination, *Toluene, *Water pollution treatment, Aerobic conditions, Desorption, Microbial degradation, Sorption rate.

Batch soil microcosms were used to evaluate the sorption and bioavailability of toluene in an organic soil containing acclimated bacteria. Most toluene sorption occurs rapidly but a small fraction (<10%) sorbs at a much slower rate that continues to decrease over time. Toluene sorption appears to be a two-phase process (fast and slow) and true equilibrium may take a significant period of time to achieve. Measurement of both sorbed and solution phase toluene concentrations indicate that acclimated bacteria quickly utilize toluene under aerobic conditions. Within 2 days total toluene was reduced below measurable levels. Desorption of most toluene from soil is rapid, thereby becoming available to acclimated bacteria in the aqueous phase. However, a small quantity of toluene desorbs very slowly and becomes available for biodegradation at a rate limited by desorption. (Author's abstract)
W90-07917

SORPTION EQUILIBRIA FOR TRICHLOROETHENE ON ALGAE.
Advanced Environmental Control Technology Research Center, Urbana, IL.
For primary bibliographic entry see Field 5D.
W90-07919

DETERMINATION AND SPECIATION OF HEAVY METALS IN SEDIMENTS OF THE PISUERGA RIVER.
Valladolid Univ. (Spain). Dept. de Quimica Analitica.
R. Pardo, E. Barrado, L. Perez, and M. Vega.
Water Research WATRAG, Vol. 24, No. 3, p 373-379, March 1990. 3 fig, 5 tab, 20 ref.

Descriptors: *Heavy metals, *Path of pollutants, *River sediments, *Sediment contamination, *Spain, Adsorption, Cadmium, Carbonates, Cobalt, Copper, Lead, Nickel, Organic matter, Pisuerga River, Principal component analysis, Speciation, Sulfides, Tessiers method, Zinc.

The contents and speciation of Zn, Cd, Pb, Cu, Ni and Co in sediments taken in the Pisuerga River, that flows through the town of Valladolid and is polluted by industrial and municipal effluents were analyzed. All heavy metals were determined by voltammetric methods, and their mean total contents were (in micrograms/gram): Zn, 245.49; Cd, 1.05; Pb, 18.77; Cu, 66.53; Ni, 46.51; and Co, 11.41. The % water, % loss at 800 C, % calcium carbonate, % organic matter and % organic N for each sediment were also determined. All the data were examined by principal components analysis in order to explain the behavior of each metal and sampling point. The speciation was carried out by Tessier's method to find five metal categories: (a) adsorptive and exchangeable, (b) bound to carbonates, (c) bound to reducible phases, (d) bound to organic matter and sulfides and (e) residual metals. Cd and Pb, and to a lesser degree Zn, appeared in fractions (a), (b) and (c), whereas Cu, Ni and Co were mainly found in fractions (c) and (d). The residual metal fractions, taken as a guide for pollution, were found to be similar to the ones obtained in rivers belonging to the same European zone. (Author's abstract)
W90-07922

POLLUTION FROM FISH FARMS.
J. G. Jones.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 14-18, February 1990. 9 ref.

Descriptors: *Fish farming, *Fisheries, *Water pollution sources, Environmental quality, Legislation, Water quality.

Fish farms are continuing to grow in numbers and in size. They cause concern because of their location in areas of high-quality water, frequently in the headwaters where there is little dilution for large volumes of effluent. This jeopardizes the water quality, and may affect the ecology of the river, migratory fish in particular. The use of chemicals for the treatment of disease is causing concern, particularly if the river is used for potable abstraction. Little information is available on the low-level effects and the detection of chemicals such as antibiotics and hormones. The chemicals are not controlled nationally, the only control being through consents. With the continued growth of the fish-farm industry, problems are likely to increase in the future unless a responsible attitude to their development is adopted. (Author's abstract)
W90-07928

PARTICULATE LEAD IN WATER SUPPLIES.
Water Research Centre, Swindon (England).
Swindon Engineering Centre.
For primary bibliographic entry see Field 5F.
W90-07929

REVIEW OF POLLUTION FROM WASTE INCINERATION.
Leeds Univ. (England). Dept. of Fuel and Energy.
For primary bibliographic entry see Field 5E.
W90-07930

RED-LIST SUBSTANCES: SELECTION AND MONITORING.
Water Research Centre, Medmenham (England).

Medmenham Lab.
For primary bibliographic entry see Field 5G.
W90-07932

INFLUENCE OF SEASONAL GROWTH, AGE, AND ENVIRONMENTAL EXPOSURE ON COPPER AND SILVER IN A BIVALVE INDICATOR, MACOMA BALTHICA, IN SAN FRANCISCO BAY.
Geological Survey, Menlo Park, CA.
D. J. Cain, and S. N. Luoma.
Marine Ecology Progress Series MESEDT, Vol. 60, No. 1/2, p 45-55, February 1990. 11 fig, 1 tab, 56 ref.

Descriptors: *Bioaccumulation, *Copper, *Heavy metals, *Mollusks, *Path of pollutants, *San Francisco Bay, *Silver, Seasonal variation, Sediment contamination, Spatial variation, Temporal variation, Tissue analysis.

Temporal and spatial variations in copper and silver in the deposit-feeding clam Macoma balthica and in surficial sediments were analyzed at 8 stations in San Francisco Bay at near-monthly intervals for periods ranging from 3 to 10 years during 1977 to 1986. Strong seasonal variations in metal concentrations of Macoma balthica were associated with seasonal variations in soft tissue weight. Aperiodic fluctuations in metal concentrations appeared to be driven by changes in metal contents of the soft tissues. Metal content of clams of standard shell length was less variable than tissue metal concentration, and generally followed changes in the concentrations of copper and silver in the sediments. Correlations between metal content and sediment concentrations were improved when content was standardized to age rather than shell length. Metal content of Macoma balthica displayed few consistent temporal trends among stations, evidently reflecting different sources of input and complex hydrologic and geochemical processes affecting metal availability in San Francisco Bay. Increases in copper and silver were noted at several stations in South Bay during 1977 to 1980. A continuous 10 year record at one of these stations showed that the 1977 to 1980 increase and the subsequent decline beginning in 1981 coincided with fluctuations in metal inputs from a nearby source. (Author's abstract)
W90-07939

DEGRADATION OF PYRIDINES IN THE ENVIRONMENT.
Ohio State Univ., Columbus. Dept. of Agronomy.
G. K. Sims, and E. J. O'Loughlin.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 1, p 309-340, January 1990. 18 fig, 246 ref.

Descriptors: *Biodegradation, *Degradation, *Fate of pollutants, *Pyridines, Herbicides, Invertebrates, Literature review, Microbial degradation, Nitrogen compounds, Photolysis, Plants, Pollutant identification, Toxicity, Water pollution effects.

Pyridine derivatives comprise a large and important class of environmental contaminants. Most environmentally significant pyridine derivatives are moderately to highly soluble, and are susceptible to transport, posing a threat of local surface or groundwater pollution. Such contamination has been verified directly through monitoring of wells and waterways proximate to sources of contamination. Mechanisms exist for photolysis, volatilization, complexation, surface attenuation, and biodegradation among pyridines which have been detected in the environment. Most of these data have been obtained under artificial conditions and should be validated by field experiments. The reactivity of pyridines is influenced by the nature and position of ring substituents. General statements regarding the environmental fate of pyridines should be precedented by the chemistry of the particular species of interest, or based upon direct experimental evidence. Biological degradation constitutes a major mechanism for detoxification or dissipation of select pyridines from the environment. A substantial quantity of research data has contributed to the understanding of the mechanisms available for catabolism of pyridine rings, although reactions peculiar to this class of com-

pounds (such as aerobic ring reduction) remain poorly understood. Best understood are the pathways involving initial hydroxylation with oxygen derived from water, and subsequent convergence of diols or triols into the maleamate pathway. Perhaps least understood are the mechanisms for catabolism of alkyl and chloropyridines, which constitute two of the largest classes of pyridines occurring in the environment. The total picture of the environmental fate of most pyridines which have been detected in surface and groundwater samples remains obscure. (Geiger-PTT)
W90-07964

DISSOLVED GAS EVIDENCE FOR DENITRIFICATION IN THE LINCOLNSHIRE LIMESTONE GROUNDWATERS, EASTERN ENGLAND.
Department of Science (Geology Division), Anglia Higher Education College, Cambridge, CB1 1PT England.
G. B. Wilson, J. N. Andrews, and A. H. Bath.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 51-60, February 1990. 3 fig, 1 tab, 21 ref.

Descriptors: *Denitrification, *Fate of pollutants, *Fertilizers, *Groundwater chemistry, *Nitrogen, *Path of pollutants, *Water chemistry, Air entrainment, Atmospheric nitrogen, Groundwater recharge.

High concentrations of dissolved nitrogen gas are present in some groundwaters within the confined zone of the Lincolnshire Limestone aquifer. Atmospheric nitrogen sources are shown to be from air equilibration at groundwater recharge and air entrainment during recharge. Nitrogen arising from these two processes can be identified and quantified by the pattern of noble gas dissolution in the groundwaters. Nitrogen which is in excess of the amounts due to these two processes is attributed to denitrification. The isotopic composition of this nitrogen gas derived from denitrification has variably light delta-15-N values. (Author's abstract)
W90-07977

SOURCES OF NITRATES IN FISSURE GROUNDWATER IN THE HUMID TROPICAL ZONE--THE EXAMPLE OF IVORY COAST (ORIGINE DES NITRATES DANS LES NAPPES DE FISSURES DE LA ZONE TROPICALE HUMIDE--EXEMPLE DE LA COTE D'IVOIRE).
Montpellier-2 Univ. (France). Lab. d'Hydrogeologie.
J. P. Faillat.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 231-264, February 1990. 11 fig, 9 tab, 71 ref. English summary.

Descriptors: *Deforestation, *Domestic wastes, *Groundwater pollution, *Nitrates, *Tropical regions, *Water pollution sources, Denitrification, Detritus, Leaching, Tracers.

High nitrate contents (up to 200 mg/L) were observed in a sample of 230 tubewells reaching fissure groundwater beneath thick layers of weathered and decayed rock, in a humid tropical zone with an annual rainfall of > 1000 mm. Examination and comparison of the regions studied led to two possible sources of the nitrates; first, classic domestic pollution, and second the leaching of the soil and rotting plant debris after local deforestation, when villages or crops were established. An attempt was made to distinguish between the two sources by using 15-N-N03. The results were rendered uncertain by the probable involvement of natural denitrification. Nevertheless, this approach provides arguments in support of nitrates originating in processes connected with deforestation. (Author's abstract)
W90-07988

ASSESSMENT OF WET DEPOSITION MECHANISMS IN AN UPLAND SCOTTISH CATCHMENT.
Macaulay Land Use Research Inst., Aberdeen (Scotland).

R. C. Ferrier, A. Jenkins, J. D. Miller, T. A. B. Walker, and H. A. Anderson.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 285-296, February 1990. 3 fig, 6 tab, 16 ref.

Descriptors: *Acid rain, *Deposition, *Interception, *Scotland, *Water pollution sources, *Watersheds, *Wet deposition, Altitude, Chemistry of precipitation, Chlorides, Evapotranspiration.

A network of collectors were installed at various altitudes and degrees of exposure in the Allt a Mharcaidh catchment, northeast Scotland, in an attempt to obtain an accurate assessment of wet deposition loading. Results indicate that the quantity and quality of bulk deposition is constant over the whole catchment. 'Enhancement deposition' as measured by a filter-gage interception collector indicate that there is the greatest deposition at higher altitudes. The concentrations of all elements, except for hydrogen, were greater than that of catchment bulk deposition at the higher altitudes; at lower altitudes enrichment was only appreciable for sodium and chloride. Input/output chloride budgets were used to assess catchment evapotranspiration rates and the relative proportions of enhancement deposition within different altitudinal ranges. The calculation gives a catchment evapotranspiration of 18.5% and a chloride enhancement deposition 2.5 times greater at high altitudes than at lower altitudes. Rainfall chemistry in this high-level Cairngorm catchment appears independent of the positioning of the rainfall collectors. Different altitudes within the catchment receive an additional loading due to enhancement deposition, dependent upon the frequency of cloud/mist cover. This additional loading must be included in the assessment of total catchment loadings and in the calculation of evapotranspiration. (Author's abstract)
W90-07990

ORGANIC CONTAMINATION OF THE BIRMINGHAM AQUIFER, U.K.
Birmingham Univ. (England). School of Earth Sciences.
M. O. Rivett, D. N. Lerner, J. W. Lloyd, and L. Clark.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 307-323, February 1990. 10 fig, 5 tab, 22 ref.

Descriptors: *England, *Groundwater pollution, *Organic pollutants, *Water pollution sources, *Water supply, Aquifers, Geohydrology, Organic solvents, Trichloroethylene.

A survey of the organic water quality of the Birmingham Triassic Sandstone aquifer was conducted using 59 supply boreholes. Additional shallow groundwater quality data were obtained from 15 monitoring wells. Chlorinated solvents are widespread in particular trichloroethylene (TCE) which is detected in 78% of supply boreholes. TCE is frequently observed at high levels with 40% of supply boreholes contaminated above 30 micrograms/L to a maximum of 5500 micrograms/L. Occasional high values are also found for 1,1,1-trichloroethane and perchloroethylene. The distribution of solvents is shown to be controlled by land use and hydrogeological factors. The overlying strata, thickness of unsaturated zone, depth of solid borehole casing and abstraction history of a borehole have important influences on solvent levels. Contamination by organic chemicals other than chlorinated solvents is low in the supply boreholes. When high contamination does occur it is usually in the form of a petrogenic hump of unresolved contaminants in the chromatogram. The source of such contamination is probably (degraded) lubricating oils. Greater contamination by general organic chemicals is seen in the shallow groundwater samples and a trend opposite that of the chlorinated solvents results. (Author's abstract)
W90-07992

YERSINIA ENTEROCOLITICA AND RELATED SPECIES ISOLATED IN THE PESARO AND URBINO AREA (ITALY) FROM 1981 TO 1986.
Urbino Univ. (Italy). Inst. of Toxicology.

Group 5B—Sources Of Pollution

A. Pianetti, F. Bruscolini, W. Baffone, G. Brandi, and L. Salvaggio.
Journal of Applied Bacteriology JABAA4, Vol. 68, No. 2, p 133-137, February 1990. 1 tab, 28 ref.

Descriptors: *Animal diseases, *Barn wastewater, *Enteric bacteria, *Human diseases, *Municipal wastewater, *Pathogenic bacteria, *Pollutant identification, Insect larvae, Italy, Mussels, Yersinia.

A total of 23 strains of yersinias, Yersinia enterocolitica (17), Y. frederiksenii (5) and Y. intermedia (1) characterized according to bio-serogroup and phage type, were isolated from humans, animal and environmental samples (municipal wastewater and wastewater from swine farms) during a 5-year period. With regard to Y. enterocolitica, the following points are noted: (1) the low frequency among subjects with gastroenteritis (1.02%); (2) the absence among subjects with other affections or clinically healthy; (3) the low frequency in animals (0.75%); (4) the absence from foods, with the exception of mussels collected from the sea; (5) the isolation from fresh fly larvae (4.54%); this finding could indicate a risk of infection for fishermen and of environmental contamination. Five strains of yersinias (all Y. enterocolitica biotype 1) were isolated from municipal wastewater, all from one sewer collector. The low prevalence of Y. frederiksenii and y. intermedia 90.23% and 0.04%) suggests that these species are normal components of aquatic ecosystems. It appears that in the Pesaro-Urbino area Yersinia spp. are infrequent and the strains of Y. enterocolitica belong to environmental and rarely to human pathogenic bioserogroups. (Sand-PTT)
W90-07999

SURVIVAL STRATEGY OF ESCHERICHIA COLI AND ENTEROCOCCUS FAECALIS IN ILLUMINATED FRESH AND MARINE SYSTEMS.
Universidad del Pais Vasco, Bilbao (Spain). Dept. de Microbiologia e Inmunologia.
I. Barcina, J. M. Gonzalez, J. Iriberri, and L. Egea.
Journal of Applied Bacteriology JABAA4, Vol. 68, No. 2, p 189-198, February 1990. 2 fig, 4 tab, 39 ref.

Descriptors: *Aquatic environment, *Enteric bacteria, *Escherichia coli, *Light effects, *Marine environment, *Path of pollutants, *Survival, Bacterial analysis, Bacterial physiology, Glucose, Illumination, Metabolism, Respiration, Visible light.

Some effects of visible light on Escherichia coli and Enterococcus faecalis in natural freshwater and seawater were studied by plate counts, colony area measurements, and direct counts. A large number of somnicells (non-culturable cells) were noted in illuminated systems as compared with non-illuminated ones. Colony areas were significantly smaller in illuminated systems. Indirect activity measurements were used to test the effects of visible light on the ability of E. coli and E. faecalis to metabolize substrates (C14-glucose) in natural waters. In illuminated systems, a decrease of glucose uptake was observed. When percentages of assimilation and respiration with respect to the total glucose uptake were analyzed, a decrease of assimilation percentages and an increase of respiration percentages were observed. In addition, differences in glucose uptake, assimilation and respiration by enteric bacteria were detected for E. coli at the beginning of the experiments between freshwater and seawater, and these were interpreted as a toxic effect exerted by seawater on E. coli cells. Differences between species, natural waters and parameters studied (excepting glucose assimilation) were detected in the illuminated systems. It is concluded, however, that enteric bacteria under visible light illumination show a general survival strategy characterized by reaching progressively a somnicell stage which can be define in terms of its inability to form colonies on standard bacteriological media, inability to incorporate substrates, and inactivation of biosynthetic processes. (Author's abstract)
W90-08000

ASSOCIATION BETWEEN EXUDATES OF BROWN ALGAE AND POLYCHLORINATED BIPHENYLS.
Alfred-Wegener-Inst. fuer Polarforschung, Bremerhaven (Germany, F.R.).
R. J. Lara, C. Wiencke, and W. Ernst.
Journal of Applied Phycology JAPPEL, Vol. 1, No. 3, p 267-270, 1989. 1 tab, 16 ref.

Descriptors: **Metabolites, *Marine algae, *Path of pollutants, *Phaeophyta, *Polychlorinated biphenyls, Bioavailability, Fate of pollutants, Seawater chemistry, Water analysis.

Organic macromolecules in seawater samples and exudates from brown algae are able to incorporate organic compounds like amino acids, sugars, and fatty acids. Exudates from the brown algae Caepidium antarcticum and Desmarestia sp. were investigated for their ability to associate with hydrophobic pollutants such as polychlorinated biphenyls (PCBs). The percentage of PCB associated with algal exudates ranged from 79% for decachlorobiphenyl to 23% for the pentachlorobiphenyl congener No. 95. Exudates from the tested brown algae may therefore alter the bioavailability of PCBs in natural or artificial ecosystems. (Sand-PTT)
W90-08002

SEROTYPES AND PYOCIN TYPES OF PSEUDOMONAS AERUGINOSA ISOLATED FROM NATURAL WATERS.
Malaga Univ. (Spain). Facultad de Ciencias.
A. De Vicente, J. C. Codina, E. Martinez-Manzanares, M. Aviles, and J. J. Borrego.
Letters in Applied Microbiology LAMIE7, Vol. 10, No. 2, p 77-80, February 1990. 2 fig, 2 tab, 19 ref.

Descriptors: *Epidemiology, *Feces, *Pseudomonas, *Water pollution, Freshwater, Pyocin types, Seawater, Serotypes.

Two important epidemiological characteristics (serotype and pyocin type) of Pseudomonas aeruginosa strains isolated from freshwater and seawater were investigated. Serotype 1 predominated, followed by serotype 6, whereas serotypes 11 and 9 were only occasionally isolated. The most frequent pyocin types from seawater and freshwater were 13B and 16B, respectively. The distribution of the different types in relation to the degree of fecal pollution was also studied. Pyocin types 12A and 13B were the best adapted to the marine environment, and serotype 10 and the pyocin type 17B were worst adapted to these aquatic environments. (Author's abstract)
W90-08015

SIMPLE METHOD FOR MONITORING MUTAGENICITY OF RIVER WATER. MUTAGENS IN YODO RIVER SYSTEM, KYOTO-OSAKA.
Okayama Univ. (Japan). Faculty of Pharmaceutical Sciences.
For primary bibliographic entry see Field 5A.
W90-08019

DISTRIBUTION AND TRANSPORT KINETICS OF RADIONUCLIDES 99-MO AND 131-I IN A SIMULATED AQUATIC ECOSYSTEM.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
M. Svadlenkova, J. Konecny, M. Obdrzalek, and L. Simanov.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 535-541, April 1990. 2 fig, 1 tab, 4 ref.

Descriptors: *Bioaccumulation, *Ecosystems, *Path of pollutants, *Radioactive wastes, *Radioactivity, Aquatic plants, Biological studies, Biomass, Filtration, Fish, Microbiological studies, Seasonal variation, Water movement.

The majority of radioactivity brought to an aquatic system from nuclear powerplant wastes is absorbed by the sediment; the remaining fraction is distributed between water and biomass. The total activity distribution among the components of the hydrosphere depends not only on the radionuclide concerned, but also on the physico-chemical properties of water and sediment, kind and amount of biomass, stagnancy or motion of water, and season of the year. Water, sediment, plants and fish were sampled from an active reservoir periodically, first in shorter and then in longer time intervals. Plants were cleaned, spread over filter paper and allowed to dry for 30 min. Fish organs were separated and each of the organs was weighed and mineralized. All samples were subjected to gamma spectrometric analysis. The radioactivities of the filters showed that bioaccumulation by living microorganisms is negligible. This is corroborated by the microbiological analysis of the water. (Brunone-PTT)
W90-08021

ACCUMULATION, METABOLISM, AND TOXICITY OF PARATHION IN TADPOLES.
Patuxent Wildlife Research Center, Laurel, MD.
R. J. Hall.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 629-635, April 1990. 1 fig, 4 tab, 8 ref.

Descriptors: *Frogs, *Larval growth stage, *Animal physiology, *Bioaccumulation, *Parathion, *Path of pollutants, *Toxicity, Biological studies, Cholinesterase, Enzymes, Mortality, Paraoxon, Tissue analysis.

Tadpoles of the bullfrog (Rana catesbiana) have a great resistance to organophosphorus pesticides and the ability to accumulate parathion and fenthion from water. Patterns of uptake and elimination of parathion were studied while examining paraoxon production in tadpoles. Tadpoles were exposed to parathion. There was no mortality of tadpoles exposed to 1 mg/L parathion, and as paraoxon increased in the water with fewer animals, parathion decreased. Presence of other metabolites increased with time and with parathion depletion. Parathion tended to increase in flowing water systems. This increase appears to be correlated with an observed increase in organic debris accumulating in the test water. Failure of paraoxon to appear in measurable quantities in flowing water systems is not unexpected as its relatively great solubility would tend to remove it with the overflow water. The poor solubility of parathion probably explains its accumulation in the flow-through tests. It has a greater affinity for organic materials than for water, and adheres to animals, fecal material and molted skin in the test containers. As testing progressed, greater amounts of suspended debris and adhering particles are collected with water samples. Paraoxon appears to be 3 to 25 times as effective as parathion in inhibiting cholinesterase in mammalian tissue in vitro. Mortality of tadpoles does not begin until levels of parathion approach 5 mg/L; the maximum level of paraoxon observed in static systems, 0.062 mg/L would produce the equivalent toxicity of only 1.5 mg/L parathion even if its effects were multiplied the full 25 times. Mortality in these experiments is explained wholly on the basis of calculated exposure to parathion. No influence of ambient paraoxon is evident. Paraoxon released by tadpoles in aquatic systems could enhance the toxicity of parathion under certain circumstances. (Brunone-PTT)
W90-08025

PROFILE OF METAL-BINDING PROTEINS AND HEME OXYGENASE IN RED CARP TREATED WITH HEAVY METALS, PESTICIDES AND SURFACTANTS.
Nagasaki Univ. (Japan). Faculty of Pharmaceutical Sciences.
T. Ariyoshi, S. Shiiba, H. Hasegawa, and K. Arizono.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 643-649, April 1990. 3 tab, 13 ref.

Descriptors: *Carp, *Enzymes, *Fish physiology, *Heavy metals, *Path of pollutants, *Pesticides, *Water pollution effects, Animal physiology, Biochemistry, Cadmium chloride, Lead acetate, Metal-binding proteins, Surfactants.

The effects of heavy metals, pesticides and surfactants on the metal-binding proteins (MBP) and the heme oxygenase in the hepatopancreas and kidney of freshwater red carp (Cyprinus carpio), were investigated. Cadmium chloride, lead acetate, O,O-diethyl-O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate (diazinon), o-sec-butyl-phenyl-N-methylcarbamate (BPMC), sodium n-dodecyl-benzenesulfonate (LAS), and polyoxyethyleneglycol nonylphenyl ether (Emulgen 913) were intraperitoneally injected into fish. Heme oxygenase activity was depressed appreciably by cadmium chloride treatment in the kidney, but no alterations were observed in that activity by lead acetate injections. Although diazinon increased the MBP content in the kidney, there were no remarkable difference in MBP content in the hepatopancreas, and no appreciable changes in the MBP content after the injection of BPMC. The non-ionic surfactant Emulgen 913 decreased the MBP content in the hepatopancreas and increased in the kidney. Similar effects on the MBP content were seen after the injection of LAS. Heme oxygenase activity in the hepatopancreas was depressed by the injection of diazinion at doses higher than 50 mg/kg, whereas that activity in the kidney was enhanced at the highest dose of 100 mg/kg; BPMC did not affect that activity in either tissue at the doses used. Both surfactants used suppressed the heme oxygenase activity in the kidney, while no significant changes were noted in the hepatopancreas. The difference in tissue responsiveness to chemical induction of heme oxygenase may reflect differences in chemical binding affinities and in cellular content of some functional groups which complex and block chemicals. (Brunone-PTT)
W90-08027

OUTBREAK OF WATERBORNE CRYPTO-SPORIDIOSIS CAUSED BY POST-TREATMENT CONTAMINATION.
Scottish Parasite Diagnostic Lab., Glasgow. Dept. of Bacteriology.
H. V. Smith, W. J. Patterson, R. Hardie, L. A. Greene, and C. Benton.
Epidemiology and Infection EPINEU, Vol. 103, No. 3, p 703-715, December 1989. 4 fig, 2 tab, 21 ref.

Descriptors: *Drinking water, *Fecal coliforms, *Human pathogens, *Path of pollutants, *Protozoa, *Seasonal variation, *Water pollution effects, *Water pollution sources, Cryptosporidiosis, Epidemiology, Excess rainfall, Water contamination.

An outbreak of waterborne cryptosporidiosis affecting 27 persons, diagnosed stool positive, occured in Ayrshire in April, 1988. Twenty-one of the 27 confirmed cases required some form of fluid replacement therapy. Local general practitioners indicated a twofold to fivefold increase in diarrheal disease during the outbreak, and following inquiries made by Environmental Health Officers, it became apparent that many hundreds of people had suffered a diarrheal illness at the time. Cryptosporidium spp. oocysts were detected in the treated chlorinated water supply system, in the absence of fecal bacterial indicators. Oocyst contamination of a break-pressure tank containing final water for distribution was the cause of this waterborne outbreak. An irregular seepage of oocyst-containing water, which increased during heavy rains, was the cause of the break-pressure tank contamination, rather than a failure of the water treatment process. The waterborne route should be considered when clusters of cryptosporidiosis associated with potable water occur. Waterborne cryptosporidiosis can occur in the absence of other fecal indicators of contamination. (Author's abstract)
W90-08029

MAINTENANCE OF COOLING TOWERS FOLLOWING TWO OUTBREAKS OF LEGIONNAIRES' DISEASE IN A CITY.
Newcastle upon Tyne Univ. (England). Div. of Community Medicine.
R. S. Bhopal, and G. Barr.
Epidemiology and Infection EPINEU, Vol. 104, No. 1, p 29-38, February 1990. 1 fig, 5 tab, 20 ref.

Descriptors: *Cooling towers, *Legionella, *Human diseases, *Monitoring, *Pathogenic bacteria, *Water quality control, Maintenance, Public health, Statistical studies, Water pollution sources.

This survey assessed the maintenance of evaporative cooling towers in Glasgow, following two Legionnaire's disease outbreaks. Information was obtained from 76 of 81 premises and a maintenance score was calculated for each of 174 towers. The quality of maintenance was extremely varied (range of maintenance scores, 8-30; mean 22 with a standard deviation of 5.0; median 23; maximum possible, 33) and some towers were neglected. Breaches of maintenance principles were mainly structural and organizational, e.g. inadequate drift control, rather than failure to use chemicals. Low maintenance scores were associated with no log book, no guidelines, no change in procedures in the last five years, solitary cooling towers, and towers on industrial premises. Despite intense publicity, the standard of cooling tower maintenance in Glasgow remains a concern. Information campaigns directed at those responsible for cooling tower maintenance are necessary. (Author's abstract)
W90-08030

BACTERIAL CONTAMINATION OF WEANING FOODS AND DRINKING WATER IN RURAL BANGLADESH.
International Centre for Diarrheal Disease Research, Dacca (Bangladesh).
F. J. Henry, Y. Patwary, S. R. A. Huttly, and K. M. A. Aziz.
Epidemiology and Infection EPINEU, Vol. 104, No. 1, p 79-85, February 1990. 2 fig, 2 tab, 23 ref.

Descriptors: *Coliforms, *Human diseases, *Pathogenic bacteria, *Public health, *Water quality control, Drinking water, Food consumption, Food preparation, Rice.

The aim of this study was to determine what weaning foods and food preparation practices expose children to a high risk of diarrheal disease through exposure to a contaminated diet. Bacterial contamination of 897 and 896 drinking water samples was assessed in a water and sanitation intervention project. The geometric mean of fecal coliforms per g or ml was 7500 in leftover rice, 140 in other types of boiled rice, 250 in milk, 4.8 in household drinking water, and 3.5 in bread. Multiplication of fecal coliforms occurred when there was a delay of more than 4 hours between preparation and consumption of food. All samples were more contaminated in the rainy than in the dry season. Strategies to reduce contamination should therefore focus on 'wet' foods, early consumption after preparation, and re-heating of leftover foods. Understanding the reasons for the faulty practices is also essential to the formulation of effective measures. (Author's abstract)
W90-08031

EXAMINATION OF THE IMPACT OF RADIOACTIVE LIQUID EFFLUENT RELEASES FROM THE RANCHO SECO NUCLEAR POWER PLANT.
Oak Ridge National Lab., TN. Health and Safety Research Div.
C. W. Miller, W. D. Cottrell, J. M. Loar, and J. P. Witherspoon.
Health Physics HLTPAO, Vol. 58, No. 3, p 263-274, March 1990. 2 fig, 9 tab, 16 ref. DOE Contracts 40-544-75 and DE-AC05-840R21400.

Descriptors: *Nuclear powerplants, *Path of pollutants, *Radioactive wastes, *Rancho Seco Nuclear Power Plant, *Water pollution sources, Cesium radioisotopes, Cobalt radioisotopes, Soil contamination.

A project has been carried out by Oak Ridge National Laboratory (ORNL) to estimate the concentrations of radionuclides in the environment resulting from the release of radioactive materials in the liquid waste effluents from the Ranch Seco Nuclear Power Plant (RNSPP), and to estimate possible radiation doses to man resulting from current environmental concerns. To accomplish the objectives of this project ORNL staff members conducted an environmental sampling program around the plant site during November and December, 1984. Elevated levels of some anthropogenic radionuclides were found in the immediate environment of the plant. This radioactive contamination occurs primarily along streams receiving effluent from the plant and in fields irrigated with water from these streams. The primary contaminants are cesium-137 and cesium-134, with lesser amounts of cobalt-60 and cobalt-58. The ingestion of fish by man, was the single most important pathway identified in this analysis. However, all specific pathways of exposure and usage factors were not precisely known for a complete dose assessment of current and potential use of contaminated water and soil around the RSNPP. The liquid effluent radionuclide releases from the RSNPP pose no significant health hazard to persons living near the RSNPP. (Author's abstract)
W90-08032

INFLUENCE OF 226-RA CONCENTRATION IN SURROUNDING ROCK ON 222-RN CONCENTRATION IN GROUND WATER.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
R. M. Davis, and J. E. Watson.
Health Physics HLTPAO, Vol. 58, No. 3, p 369-371, March 1990. 2 tab, 5 ref.

Descriptors: *Groundwater pollution, *Radium radioisotopes, *Radon radioisotopes, *Water pollution sources, *Well water, Drilling, Geochemistry, Monitoring.

Researchers have performed many studies of radon is groundwater in North Carolina, in other sections of the United States, and in other countries. This study was conducted to investigate reasons for the variation in radon concentrations in water from different wells drilled in the same granite platform. More specifically, rock cuttings obtained from the granite during the drilling of the study wells were analyzed to study whether the concentrations of radium-226 in the surrounding crystalline rock were correlated with concentrations of radon-222 in the groundwater. Rock and water samples were collected from six wells drilled in the Rolesville pluton just east of Raleigh, North Carolina over a period of six months. There was no apparent correlation between the radon-226 concentration in the granite cuttings obtained from each well site and the radon-222 concentration in water from the well. The radon-226 concentrations in cuttings from wells 1 and 2 were identical, but the radon-222 concentration in well 2 was approximately 6.5 times that in well 1. These wells were approximately 0.4 km apart. For the six wells, the ratio of the maximum to the minimum radon-226 concentration in rock was 1.5, whereas this ratio for radon-222 in water was 7.9. There was also a lack of correlation between the hydrogen ion concentration or total dissolved solids and the radon-222 concentration in the groundwater samples. This study provided further evidence of the complexity associated with trying to predict radon-222 concentrations in groundwater, even from wells drilled in the same type of rock. For the wells in this study, it was concluded that there was no correlation between the radon-226 concentrations in the cuttings from the well site and the radon-222 concentration in the groundwater collected from the well. (Brunone-PTT)
W90-08033

WATERBORNE DISEASE OUTBREAKS, 1986-1988.
For primary bibliographic entry see Field 5C.
W90-08034

TRIHALOMETHANES (THMS) FORMATION IN MULTI-STAGE FLASH (MSF) DISTILLATION PLANTS.
Kuwait Water Resources Development Centre, Safat.
For primary bibliographic entry see Field 3A.
W90-08050

SEASONAL VARIABILITY OF N:P RATIOS IN EUTROPHIC LAKES.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B—Sources Of Pollution

National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
J. Barica.
Hydrobiologia HYDRB8, Vol. 191, p 97-103, February 28, 1990. 4 fig, 1 tab, 14 ref.

Descriptors: *Eutrophic lakes, *Limnology, *Manitoba, *Nutrients, *Path of pollutants, *Seasonal variation, Cyanophyta, Nitrogen, Nitrogen fixation, Nitrogen-phosphorus ratio, Phosphorus.

The ratios of different forms of N and P (particulate, total, total dissolved, and dissolved inorganic N:P) from eutrophic lakes (Manitoba, Canada) are presented to assess their variability during two consecutive growing seasons. Particulate and total N:P ratios showed the lowest amplitude of fluctuations, whereas the total inorganic N:P ratios showed the highest. All N:P forms demonstrated substantial variation and seasonal pattern over the growing period April-October. Short-lasting spring minima of the N:P ratios, ranging from less than 1:1 to 6:1, triggered the onset of N-fixing cyanophyte blooms. Seasonal mean values were as high as 20:1 to 30:1 and misleading in assessing N limitation. The N fixation rapidly restored the N:P values to normal levels (TN:TP of 15:1 or more). (Author's abstract)
W90-08075

INFLUENCE ON PHYTOPLANKTON BIOMASS IN LAKES OF DIFFERENT TROPHY BY PHOSPHORUS IN LAKE WATER AND ITS REGENERATION BY ZOOPLANKTON.
Polish Academy of Sciences, Mikolajki. Hydrobiological Research Station.
For primary bibliographic entry see Field 5C.
W90-08078

SEDIMENT CHEMISTRY AND ATMOSPHERIC CONTAMINATION.
Ulster Univ., Coleraine (Northern Ireland). Limnology Lab.
B. Rippey.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 311-317, March 12, 1990. 4 fig, 24 ref.

Descriptors: *Acid rain, *Air pollution, *Lake sediments, *Limnology, *Path of pollutants, *Sediment chemistry, *Sediment contamination, Concentration-depth profiles, Lake acidification, Polycyclic aromatic hydrocarbons, Scandinavia, Scotland, Sulfur, Trace metals.

The trace metal, sulfur and polycyclic aromatic hydrocarbon concentration-depth profiles in dated lake-sediment cores are used to establish the history of contamination of the atmosphere above the study lakes. The results from three chemical groups give the same qualitative description of contamination. The atmosphere became contaminated in the areas of high present day acid deposition early last century in Scotland and late last century in southern Scandinavia. Contamination increased this century and the sulfur, polycyclic aromatic hydrocarbons and sometimes the trace metal fluxes to the sediment drop over the past 10-30 years. There was little or no contamination at the low recent acid-deposition sites in both study regions. (Author's abstract)
W90-08107

BRITISH AND SCANDINAVIAN LAKE SEDIMENT RECORDS OF CARBONACEOUS PARTICLES FROM FOSSIL-FUEL COMBUSTION.
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 2H.
W90-08108

LAKE SEDIMENT MAGNETISM AND ATMOSPHERIC DEPOSITION.
Liverpool Univ. (England). Dept. of Geography.
F. Oldfield, and N. Richardson.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 325-330, March 12, 1990. 2

fig, 6 ref.

Descriptors: *Acid rain, *Air pollution, *Lake sediments, *Magnetic studies, *Paleolimnology, *Particulate matter, *Path of pollutants, Fly ash, Hematite, History, Industrial wastes, Lithology, Magnetite, Sediment chemistry.

Many recent lake sediment profiles contain atmospherically derived fly ash and various particles from industrial processes. All these include a magnetic fraction that can be studied by subjecting subsamples to controlled magnetic fields in the laboratory and measuring the isothermal remanences acquired. These provide a basis for partially characterizing and roughly quantifying the magnetic minerals preserved in the sediments. Although the value of the magnetic record as an indicator of atmospherically-derived industrial particulate deposition in recent lake sediments is strongly dependent upon the lithology of, and surface processes operating within, the lake catchment. Results obtained from some 70% of the 39 profiles taken from 32 sites mostly in upland Wales and the Scottish Highlands indicate widespread increases in magnetite and hematite deposition beginning from the mid-nineteenth century onwards and steepening in the last three to five decades. (Brunone-PTT)
W90-08109

RECORD OF ATMOSPHERIC DEPOSITION ON A RAINWATER-DEPENDENT PEATLAND.
Queen Mary Coll., London (England). School of Biological Sciences.
For primary bibliographic entry see Field 2H.
W90-08110

CAUSES OF LAKE ACIDIFICATION, WITH SPECIAL REFERENCE TO THE ROLE OF ACID DEPOSITION.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 2H.
W90-08111

12,600 YEAR PERSPECTIVE OF THE ACIDIFICATION OF LILLA ORESJON, SOUTHWEST SWEDEN.
Umea Univ. (Sweden). Dept. of Ecological Botany.
I. Renberg.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 357-361, March 12, 1990. 2 fig, 10 ref.

Descriptors: *Acid rain, *Diatoms, *Lake acidification, *Paleolimnology, *Sediment analysis, *Sweden, Agriculture, Alkalinity, Glaciation, Hydrogen ion concentration, Lilla Oresjon, Path of pollutants, Radioactive dating, Species composition.

The hydrogen ion concentration history of Lilla Oresjon was studied by using diatom analyses of a 3.5 m long sediment core (700 contiguous 0.5 cm samples). Radiocarbon and lead-210 were used to date the samples. Four hydrogen ion concentration periods were distinguished: (i) an alkaline period (12,600-7800 BP) following deglaciation, (ii) a naturally acidic period (7800-2300 BP) when the hydrogen ion concentration decreased from 6.0 to 5.2, (iii) a period with higher hydrogen ion concentrations (greater than 6) (2300 BP-1900 AD), which started at the same time as agriculture expanded, and (iv) the recent acidification period that began with a deterioration phase around 1900 AD and developed into an acute acidification phase during the 1960s (hydrogen ion concentration of 4.5). This post-1960 phase has no similarity with any of the previous periods identified. (Author's abstract)
W90-08113

EFFECTS OF ACIDIC DEPOSITION ON NORTH AMERICAN LAKES: PALAEOLIMNOLOGICAL EVIDENCE FROM DIATOMS AND CHRYSOPHYTES.

Indiana Univ. at Bloomington. Dept. of Biology.
D. F. Charles.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 403-412, March 12, 1990. 1 fig, 1 tab, 54 ref.

Descriptors: *Acid rain effects, *Chrysophyta, *Diatoms, *Lake acidification, *North America, *Paleolimnology, *Sediment analysis, Air pollution, Calibrations, Ecosystems, Hydrogen ion concentration, Path of pollutants, Species composition, Species diversity.

Analysis of sediment diatom and chrysophyte assemblages is the best technique currently available for inferring past lake water hydrogen ion concentration trends. Use of this approach for assessing the ecological effects of acidic deposition is increasing rapidly. As of August, 1989, sediment core inferred hydrogen ion concentration data existed for at least 150 lakes in North America and cores from about 100 more lakes are being analyzed. Equations for inferring past hydrogen ion concentrations are based on at least 15-20 calibration data-sets involving about 700 lakes. Paleolimnological studies indicate that recent acidification has been caused by acidic deposition in the Adirondack Mountains (New York), northern New England, Ontario, Quebec and the Canadian Atlantic provinces. Inferred hydrogen ion concentration decreases are commonly as much as 0.5-1.0 hydrogen ion concentration units. With the exception of one lake, no acidification trends were observed in regions currently receiving low deposition of strong acids. Slight or no trends towards decreasing hydrogen ion concentration were observed in study lakes receiving moderately acidic deposition (upper Midwest and northern Florida). The amount of inferred acidification correlates with the amount of sulfur and nitrogen loading and the ability of watersheds and lakes to neutralize acid inputs and is generally consistent with current lake-acidification theory. In most cases, the primary cause of recent acidification (post-1850) is acidic deposition, as opposed to land-use changes or natural processes, though these might be contributing factors. Acid loading has increased in some regions since 1970. Some lakes have become less acidic in response, but others continue to lose acid neutralizing capacity. (Author's abstract)
W90-08120

EVALUATION OF CLAMSHELL DREDGING AND BARGE OVERFLOW, MILITARY OCEAN TERMINAL, SUNNY POINT, NORTH CAROLINA.
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 6G.
W90-08139

SUBSURFACE AGRICULTURAL DRAINAGE IN CALIFORNIA'S SAN JOAQUIN VALLEY.
California State Dept. of Water Resources, Sacramento.
R. L. Brown, and L. A. Beck.
IN: Biotreatment of Agricultural Wastewater. CRC Press, Inc., Boca Raton, Florida. 1989. p 1-13, 5 fig, 3 tab, 17 ref.

Descriptors: *California, *Regulations, *San Joaquin River, *Selenium, *Standards, *Water pollution control, *Water pollution sources, Agricultural runoff, Bacteria, Biological treatment, Boron, Marshes, Molybdenum, Ponds.

Drainage problems have been around for some time, as has the perceived need to remove something from the water to make discharge of the water to a salt sink environmentally acceptable. This 'something' has varied from total salts to nitrogen to pesticides to various trace elements, including selenium. As part of its Order WQ 85-1, the California State Water Resources Control Board established interim standards for the San Joaquin River for total salts, boron, selenium, and molybdenum. The interim selenium objective of 5 micrograms/L will likely drop to 2 micrograms/L after a few years. In the Grasslands Water District, duck club managers have long used subsurface

drainage as an important part of their water supply. The blended drainage water, which was moderately high in selenium (in the 50 to 100 microgram/L range), flowed through the marshes and out to the San Joaquin River. Marsh vegetation and bacteria acted as a biological treatment system and removed much of the selenium as the water passed through the system. As a result of Order WQ 85-1 and concerns associated with elevated selenium levels in waterfowl, the duck clubs no longer take drainage water. The water now goes directly to the San Joaquin River, and treatment may be required to meet the new water quality objectives established for the river. Publicity over the Kesterson findings and concern over the possibility of similar problems with wildlife refuges receiving return flows from agriculture and other sources has resulted in the so-called 'westwide study'. In this study, the US Geological Survey and US Fish and Wildlife Service are conducting reconnaissance-level studies to determine if selenium or other trace elements are causing problems in other refuges throughout the West. In California, the Salton Sea and the Tulare Lake basin are included in the study program, and preliminary results have shown elevated selenium levels in biota from these two areas. (See also W90-08141) (Lantz-PTT)
W90-08142

BACTERIAL DECONTAMINATION OF AGRICULTURAL WASTEWATERS.
Idaho Univ., Moscow. Dept. of Bacteriology and Biochemistry.
For primary bibliographic entry see Field 5D.
W90-08147

ALGAE AS IDEAL WASTE REMOVERS: BIOCHEMICAL PATHWAYS.
University of Southern Mississippi, Bay St. Louis. Center for Marine Science.
For primary bibliographic entry see Field 5D.
W90-08148

LOGS OF WELLS AND BOREHOLES DRILLED DURING HYDROGEOLOGIC STUDIES AT LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300. JUNE 1, 1982-JUNE 30,1988.
Brown and Caldwell, Pleasant Hill, CA.
For primary bibliographic entry see Field 7C.
W90-08155

HEAVY METALS, CARBON AND HYDROCARBONS IN THE SEDIMENTS OF TABLE BAY HARBOUR.
Sea Fisheries Research Inst., Cape Town (South Africa).
J. L. Henry, S. McGibbon, G. Davis, R. M. MacKay, and A. G. S. Moldan.
Special Report 4, 1989. 26p, 17 fig, 10 tab, 7 ref, 3 append.

Descriptors: *Heavy metals, *Hydrocarbons, *Organic carbon, *Path of pollutants, *Sediment contamination, *South Africa, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Marine sediments, Mercury, Nickel, Table Bay Harbor, Zinc.

Sediments can generally be considered as the ultimate sink or depository for the majority of elements and substances. Heavy metals in particular, introduced into the sea from natural or anthropogenic sources, stay only briefly in the receiving water column before being incorporated into the bottom sediments. A preliminary survey of heavy metals in the surface sediments of five major South African harbors indicated that, in four of them (Richards Bay, Durban, East London and Port Elizabeth), one or more of the metals occurred at concentrations above normal background levels, the most frequent contaminants being copper, zinc, lead and mercury. The present survey was designed to assess the degree of contamination of sediments in Table Bay Harbor, Cape Town, and to identify the sources of the contaminants. Sediment cores were collected from 46 stations within the harbor by a team of SCUBA divers over two days of sampling, and analyzed for metals, carbon,

and hydrocarbons. The results of these analyses are presented in tabular form. Generally, of the heavy metals, iron was found in the highest concentrations (at a maximum of 13,040 micrograms/gm dry mass) and cadmium in the lowest concentrations (at a minimum of < 0.01 micrograms/gm dry mass). Total carbon ranged from 35 and 182 mg/gm, organic carbon ranged between 2 and 118 mg/gm, and hydrocarbons ranged from none measured to 14 micrograms/gm. A comparison of metal concentrations in the sediments of Table Bay Harbor with those in other South African harbors revealed that it has high levels of copper, zinc, lead, mercury and cadmium, all metals that are typically found at elevated levels in industrial and urban environment. (Lantz-PTT)
W90-08161

EUTROPHICATION IN THE UNITED KINGDOM--TRENDS IN THE 1980S.
J. W. G. Lund, and B. Moss.
The Soap and Detergent Industry Association, 1990. 82p, 1 tab, 92 ref, append.

Descriptors: *Eutrophication, *Phosphates, *Reviews, *Water pollution sources, Detergents, Great Britain, Phosphorus removal, Wastewater treatment, Water pollution control.

Phosphorus in the form of phosphate is one of the most important and least toxic substances affecting the growth of plants and animals. In most natural and many seminatural waters it is the major substance controlling plant and so, in turn, animal production. The problem of eutrophication is that in large quantities phosphates may produce undesired quantitative and qualitative changes. Sewage is the main cause of undesirable eutrophication. The phosphate content of detergents has been restricted to varying degrees in many of the richer countries. However, it is clear that the British examples given in this report, that removal of detergent phosphorus often is not sufficient to solve eutrophication problems; it also lacks flexibility because it imposes the same degree of reduction in the phosphate input to all the waters concerned. The needs for phosphorus reduction in the restoration of waters harmed by eutrophication are not necessarily the same. Removal of phosphate from sewage effluent offers flexibility and the ability to reduce the phosphorus load to a greater extent. On the other hand, removal of detergent phosphorus may be sufficient to alleviate eutrophication in places where sewage treatment does not include provision for phosphate removal. (Lantz-PTT)
W90-08167

ANALYTICAL SOLUTION FOR STEADY-STATE FLOW BETWEEN AQUIFERS THROUGH AN OPEN WELL.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-08187

MODELING OF GROUND-WATER CONTAMINATION CAUSED BY ORGANIC SOLVENT VAPORS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 2F.
W90-08189

INTEGRATED APPROACH TO IDENTIFYING THE SALINITY SOURCE CONTAMINATING A GROUND-WATER SUPPLY.
Civil and Environmental Consultants, Inc., Pittsburgh, PA.
M. Knuth, J. L. Jackson, and D. O. Whittemore.
Ground Water GRWAAP, Vol. 28, No. 2, p 207-214, March/April 1990. 8 fig, 1 tab, 11 ref.

Descriptors: *Geochemistry, *Geophysical methods, *Groundwater pollution, *Saline groundwater, *Saline water, *Water pollution sources, Brines, Chlorides, Drilling, Ohio, Pumping tests.

An integrated approach involving geohydrological, geochemical, and geophysical methods was

used to determine the source of salinity contaminating a groundwater supply in an area of Ohio where three possible sources existed: road salting, naturally saline groundwater at depth, and formation brines placed in surface pits during drilling of a gas well. Changes in chloride concentrations during pumping tests of contaminated wells indicated that the main source of salinity was derived from within the water table aquifer. Mixing curves of Br/Cl versus chloride concentration were used to determine which of each of the three salinity sources was the primary source affecting different well waters. The major source affecting the groundwater supply was found to be the formation brines associated with the gas well drilling. Geophysical surveys using electromagnetic induction and dipole-dipole electrical resistivity methods provided a three-dimensional view of the brine contamination plume in the unsaturated and saturated zones in the area of the gas well. The plume location and orientation confirmed that the formation brine from the blow-down pits used during drilling of a nearby gas well was the primary source polluting the groundwater supply in the study area. (Author's abstract)
W90-08190

OASIS: A GRAPHICAL DECISION SUPPORT SYSTEM FOR GROUND-WATER CONTAMINANT MODELING.
Groundwater Services, Inc., Houston, TX.
C. J. Newell, J. F. Haasbeek, and P. B. Bedient.
Ground Water GRWAAP, Vol. 28, No. 2, p 224-234, March/April 1990. 20 fig, 1 tab, 38 ref.

Descriptors: *Computer models, *Computer programs, *Data storage and retrieval, *Decision support systems, *Expert systems, *Groundwater pollution, *Model studies, *Path of pollutants, Biodegradation, Decision making, Documentation, Groundwater management, Hydrologic data collections.

Three new software technologies were applied to develop an efficient and easy-to-use decision support system for groundwater contaminant modeling. Graphical interfaces create a more intuitive and effective form of communication with the computer compared to text-based interfaces. Concepts from the field of hypertext were applied to design the extensive electronic documentation and databases. Finally, object-oriented programming permitted scientists with little programming experience to develop the system by manipulating preexisting software objects instead of writing computer code, greatly increasing the productivity of the project team. Decision support systems are designed to help users with broad semi-structured problems, with the user directing the problem-solving process. The decision support software named the OASIS system provides groundwater modelers with a groundwater biodegradation model, model documentation, background information, data from chemical and hydrogeologic databases, and data management tools. The system was developed using HyperCard software on a Macintosh personal computer. It currently has over 1700 different computer screens of information and occupies approximately 10 megabytes of hard disk storage. OASIS is a new type of modeling software where groundwater models, data, and knowledge are integrated together using a graphical interface and an easily modified software architecture. Two groups of users can benefit from the system: current modelers who need more efficient interfaces and data management tools, and people who are not using models now because the modeling process is too involved and requires specialized knowledge. (Author's abstract)
W90-08192

HYDROCARBON THICKNESS FLUCTUATIONS IN MONITORING WELLS.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 2F.
W90-08194

LABORATORY STUDY OF THE DISPERSION SCALE EFFECT IN COLUMN OUTFLOW EXPERIMENTS.

University of Agriculture, Faisalabad (Pakistan).

A. O. Khan, and W. A. Jury.

Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 2, p 119-131, January 1990. 5 fig, 3 tab, 34 ref.

Descriptors: *Path of pollutants, *Soil dispersants, *Soil water, *Solute transport, *Unsaturated flow, Convection, Dispersion coefficient, Dispersivity, Flow rates, Laboratory methods, Leaching, Soil columns.

A solute transport study was designed to test the validity of the convection-dispersion model in a series of experiments which varied soil column width and length. The studies were performed at three steady-state water flux rates (8, 4, 2 cm/d) in both undisturbed and packed columns containing Tujunga (California) loamy sand. Pulses of CaCl2 were leached through each column at each flow rate, after which the columns were cut in half and the experiments repeated with the upper portion of the old columns. Finally, the columns were cut a second time and the upper portion used in the final set of experiments. The resulting breakthrough curves were used to test two solute transport models, the one-dimensional convection-dispersion equation, CDE, and the mobile-immobile water model, MIM. The breakthrough curves from the undisturbed soil were very skewed, showing both early breakthrough and extensive tailing, whereas the outflow pulses from the repacked columns were symmetric. The CDE dispersion coefficient D or dispersivity significantly increased with increasing column length in the undisturbed soil columns at the higher flux rates, but D was length-independent and considerably smaller in the repacked columns than in the undisturbed soil experiments. Although the MIM model gave a good description of the extensive tailing of the breakthrough curves in any single outflow experiment, its refitted parameters showed no consistent relationship with any of the experimental variables and were generally not invariant with length. (Author's abstract)

W90-08202

FACTORS CONTROLLING THE CONCENTRATION OF METHANE AND OTHER VOLATILES IN GROUNDWATER AND SOIL-GAS AROUND A WASTE SITE.

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.

C. Barber, G. B. Davis, D. Briegel, and J. K. Ward.

Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 2, p 155-169, January 1990. 6 fig, 1 tab, 20 ref.

Descriptors: *Fate of pollutants, *Groundwater pollution, *Landfills, *Methane, *Path of pollutants, *Volatile organic compounds, Advection, Aeration zone, Capillarity, Diffusion, Diffusion coefficient, Groundwater movement, Sand aquifers, Saturation zone, Seasonal variation, Soil gases, Vapor pressure.

The concentration of methane in groundwater and soil gas in the vicinity of a waste landfill on an unconfined sand aquifer has been investigated in detail. These data have been used to evaluate techniques which use volatile organic compounds in soil gas as indicators of groundwater contamination. Simple one-dimensional models of gas advection and diffusion have been adapted. Lateral advection of gas in the unsaturated sand was found to be seasonal and was most noticeable in winter when the profile was wet. The effects of advection on trace concentrations of methane in soil gas were limited to within 150-200 meters from the waste site and resulted from pressure gradients brought about by positive gas pressures in the landfill, and also as a result of ebullition from contaminated groundwater. The distribution of methane in soil gas at shallow depth gave a general indication of the direction of movement of contaminants with groundwater in close proximity to the landfill. Outside this zone, diffusional transport of methane

was found to be a useful indicator of contaminated groundwater. Modeling the exchange of volatiles between aqueous and gas phases indicates that a wide range of organic compounds would have potential for use as indicators of pollution, if these were present in groundwater and if they behaved relatively conservatively. In general, the principal factors controlling the concentration of these volatiles in soil gas were the concentration gradient at the water table and capillary fringe and the ratio of diffusion coefficients in the saturated and unsaturated zones. (Author's abstract)

W90-08204

IMPACT OF UNCERTAINTY IN SOIL, CLIMATIC, AND CHEMICAL INFORMATION IN A PESTICIDE LEACHING ASSESSMENT.

California Univ., Berkeley. Dept. of Plant and Soil Biology.

K. Loague, R. E. Green, T. W. Giambelluca, T. C. Liang, and R. S. Yost.

Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 2, p 171-194, January 1990. 12 fig, 15 tab, 21 ref. see Vol. 5 No. 4. for corrected version of this article.

Descriptors: *Groundwater pollution, *Leaching, *Path of pollutants, *Pesticides, *Triazine herbicides, *Uncertainty, *Urea pesticides, Atrazine, Chemical properties, Climatic data, Data interpretation, Decision making, Diuron, Geohydrology, Hawaii, Pearl Harbor, Regulations, Soil properties.

The potential for various organic chemicals to leach to groundwater can be indicated qualitatively using a simple mobility index, which can be used to generate rating maps when combined with a geographic information system. The Pearl Harbor Basin, Oahu, Hawaii, was investigated with respect to the magnitude of uncertainty associated with pesticide mobility estimates as a result of data uncertainties. The two pesticides included in the analysis are atrazine and diuron. The mobility index used is known as the Attenuation Factor (AF); it requires soil, hydrogeologic, climatic, and chemical information as input data. First-order uncertainty analysis was employed to characterize the uncertainty in estimates of AF resulting from uncertainties in the various input data. Soils in the Pearl Harbor Basin were delineated at the order taxonomic category for this study. Results show that there can be a significant amount of uncertainty in estimates of pesticide mobility for the Pearl Harbor Basin. This information needs to be considered if future decisions concerning chemical regulation are to be based on estimates of pesticide mobility determined from simple indices. (Author's abstract)

W90-08205

FIELD-OBSERVED ETHYLENE DIBROMIDE IN AN AQUIFER AFTER TWO DECADES.

Connecticut Agricultural Experiment Station, New Haven.

J. J. Pignatello, C. R. Frink, P. A. Marin, and E. X. Droste.

Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 2, p 195-214, January 1990. 6 fig, 4 tab, 29 ref.

Descriptors: *Fate of pollutants, *Fumigants, *Groundwater pollution, *Path of pollutants, *Pesticides, *Soil contamination, Biodegradation, Connecticut, Equilibrium, Ethylene dibromide, Flow velocity, Glacial sediments, Groundwater movement, Vadose zone.

The fate and transport of the soil fumigant, 1,2-dibromoethane (EDB) was studied at a former tobacco field in Simsbury, Connecticut where it was last used in 1967. The subsurface consists of glacial deposits of stratified sand, gravel, and silt underlain by a fractured sandstone/siltstone bedrock. Contaminant plumes in the bedrock had migrated only slightly from beneath the tobacco field after nearly two decades, consistent with calculated flow velocities. Contaminant levels in the overburden aquifer were much lower, which was consistent with higher calculated flow velocities resulting in off-site discharge to a nearby stream, and possibly with faster biodegradation. EDB concen-

trations in both zones were stable over the study period (1.5-2 years). Earlier demonstrations of relatively fast biodegradation of 14C-EDB in aquifer core samples were contradicted by the plume stabilities observed here. EDB was found in vadose cores, particularly topsoils, at concentrations up to 32 micrograms/kilogram. These residues could not be extracted with water, even after 20 days, and were unavailable for biodegradation. By contrast added 14C-EDB was mineralized almost completely in 22 days. EDB was also found in overburden aquifer cores, in some cases at concentrations much greater than predicted from equilibrium partition experiments. The results show that kinetically slow, nonequilibrium sorption is a factor in the decades-long persistence of this chemical in the topsoil and possibly in the aquifer. (Author's abstract)

W90-08206

SHORE ATTACHMENT OF BUOYANT EFFLUENT IN STRONG CROSSFLOW.

McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.

V. H. Chu, and M. S. T. Abdelwahed.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 2, p 157-175, February 1990. 11 fig, 2 tab, 21 ref.

Descriptors: *Effluent streams, *Flow characteristics, *Open-channel flow, *Path of pollutants, *Thermal pollution, Buoyancy, Heated water, Laboratory methods, Plumes, Water circulation.

The shore attachment of buoyant effluent in a strong crossflow was investigated experimentally. The effluent, in the form of a thermal plume deflected by the crossflow, was created in the laboratory by discharging warm water from a side channel into an open-channel crossflow of the same depth as the side-channel discharge. The plume had a tendency to lift off the channel bottom and move away from the shoreline. However, when the crossflow was sufficiently strong, the plume reattached to the shoreline, and a recirculating flow region formed on the lee of the effluent. Temperature measurements were made in the plumes. The strong crossflow condition required for shore attachment was determined from the experimental investigation. Under the strong crossflow condition, the recirculating region remained attached to the shoreline, and the dilution of the plume was relatively independent of buoyancy effects. (Author's abstract)

W90-08207

REGIONAL ANALYSIS OF STREAM SALINISATION IN SOUTHWEST WESTERN AUSTRALIA.

Water Authority of Western Australia, Perth.

N. J. Schofield, and J. K. Ruprecht.

Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 19-39, December 1989. 10 fig, 4 tab, 20 ref.

Descriptors: *Australia, *Geochemistry, *Saline water, *Stream pollution, Agricultural watersheds, Catchment areas, Drought effects, Forest watersheds, Groundwater depletion, Land use, Rainfall, Rainfall-runoff relationships, Regional analysis, Saline soils, Salts, Solute transport.

Stream salinities in southwest Western Australia are strongly influenced by land use, soil salt storage and rainfall. The salinities of forest catchments are fresh and have declined over the last two decades due to decreasing groundwater solute discharge under lower than average rainfall conditions. Catchments extending to or lying in lower rainfall areas (<900 mm/year) where agricultural clearing has taken place have stream salinities ranging from marginal to saline. Over the last 20 years stream salinities have increased rapidly on these catchments. Higher stream salinities are associated with higher catchment salt storage (lower rainfall) and a higher proportion of catchment cleared. Annual salinities of salt-affected catchments vary inversely with annual rainfall. A projected trend of decreasing rainfall is likely to exacerbate the stream salinity problem. (Author's abstract)

W90-08215

GROUNDWATER CONTAMINATION AND POLLUTION IN MICRONESIA.
Societe Anonyme Francaise d'Etudes, de Gestion, et d'Enterprise, Nanterre (France).
M. Detay, E. Alessandrello, P. Come, and I. Groom.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 149-170, December 1989. 6 fig, 3 tab, 11 ref.

Descriptors: *Drinking water sources, *Groundwater pollution, *Pacific Islands, *Water pollution effects, *Water pollution sources, Administrative agencies, Catchment areas, Decision making, Education, Environmental protection, Erosion, Farm wastes, Human diseases, Industrial wastes, Management planning, Micronesia, Nonpoint pollution sources, Saline water, Saline water intrusion, Storm runoff, Water supply, Watershed management, Wells.

One of the primary sources of drinking water in the Trust Territory of the Pacific Islands (TTPI) is rainfall catchment systems, followed by rivers, springs, shallow wells, skimming wells, infiltration galleries, and deep drilled wells. Sources of groundwater pollution include industrial chemical pollution, agriculture, construction, saltwater intrusion, abandoned or improperly constructed wells, water supply wells, storm drainage, sumps and dry wells, erosion, sewage and waste water, land disposal, sanitary landfills, and graveyards. In the TTPI water supplies fall into three categories according to owner and/or operator: (1) individual or family owned and operated systems; (2) small village or community systems; and (3) large population center and/or public works operated systems. The diseases considered related to water supply include bacterial diseases, gastroenteritis, typhoid, paratyphoid, cholera, diarrheal disease, shigellosis (bacillary dysentery), hepatitis A (infectious hepatitis), amebiasis (amoebic dysentery), ascariasis, and schistosomiasis. A four-point groundwater protection strategy has been proposed: (1) establishment of planning and management practices; (2) improvement of government coordination; (3) improvement of utility system management; and (4) provision of information for decision making and public education. Providing safe drinking water to the people of the TTPI can be accomplished with time, money, and dedicated effort, in combination with other efforts to improve overall sanitation, health care, and public education. (Fish-PTT)
W90-08223

SEASONAL FLUCTUATION IN DELTA N15 OF GROUNDWATER NITRATE IN A MANTLED KARST AQUIFER DUE TO MACROPORE TRANSPORT OF FERTILIZER-DERIVED NITRATE.
Indiana Univ., Bloomington. Dept. of Geology.
E. R. Wells, and N. C. Krothe.
Journal of Hydrology JHYDA7, Vol. 112, No. 1/2, p 191-201, December 1989. 3 fig, 2 tab, 26 ref.

Descriptors: *Farm wastes, *Groundwater pollution, *Isotopic tracers, *Karst, *Karst hydrology, *Nitrates, *Nitrogen, *Path of pollutants, *Water pollution, Agricultural chemicals, Aquifers, Cropland, Effluents, Fertilizers, Geologic control, Indiana, Inorganic compounds, Interstitial water, Isotopes, Pore size, Porosity, Seasonal variation, Septic wastewater, Wells.

Groundwater nitrate pollution is caused by crop cultivation and disposal of sewage and animal wastes transported from source to aquifer by many hydrologic and geologic factors. Twenty wells in southern Indiana were sampled and analyzed for nitrate content and nitrogen isotopes in order to determine the primary origin of the groundwater nitrate. Eleven samples had groundwater nitrate delta N15 values indicating an animal waste origin. Macropores draining septic tank filter fields are probably the predominant source of waste-derived nitrate, and may provide a nearly continuous flow of effluent to the aquifer. The delta N15 values of the other nine samples suggest a possible mixing of waste-derived nitrate and that derived from isoto-

pically lighter cultivation sources. The twenty wells were resampled shortly after inorganic fertilizers had been applied to the cropland throughout the study area. Nineteen of the wells showed a shift towards the lighter delta N15 values expected from fertilizer-derived nitrate. Despite the apparent influx of fertilizer-derived nitrate, eleven samples still were composed of predominantly waste-derived nitrate. Only nine samples may have had a fertilizer-derived component approaching in magnitude that of waste-derived nitrate. Regional groundwater nitrate concentration did not substantially increase. Macropore flow appears to contribute significantly to the recharge of the aquifer. Rapid response of the groundwater nitrate values to fertilization demonstrates the ability of macropore flow to transport fertilizer-derived nitrate which has been flushed from the tilled soil layer. Other agriculture chemicals may also be transported to the aquifer in this manner. (Author's abstract)
W90-08225

FLY ASH DYNAMICS IN SOIL-WATER SYSTEMS.
Energy and Environment Group, New Delhi, India.
S. Sharma, M. H. Fulekar, and C. P. Jayalakshmi.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 3, p 251-275, 1989. 2 fig, 10 tab, 110 ref.

Descriptors: *Coal wastes, *Fly ash, *Groundwater pollution, *Soil contamination, *Waste utilization, *Water pollution sources, Bioaccumulation, Electric powerplants, Path of pollutants, Physicochemical properties, Radioisotopes, Reviews, Soil amendments, Soil properties, Trace metals.

Studies regarding the effluents and coal ashes (or fly ash) resulting from coal burning are numerous, but their disposal and interactions with the soil and water systems and their detailed environmental impact assessment with concrete status reports on a global scale are scanty. Fly ash dynamics in soil and water systems are reviewed. After detailing the physical composition of fly ash, physicochemical changes in soil properties due to fly ash amendment are summarized. Areas covered include texture and bulk density, moisture retention, change in chemical equilibria, and effects of fly ash on soil microorganisms. Plant growth in amended soils is discussed, as well as plant uptake and accumulation of trace elements. In order to analyze the effect of fly ash on the physicochemical properties of water, several factors must be considered, including surface morphology of fly ash, pH of the ash sluice water, pH adjustments, leachability and solubility, and suspended ash and settling. The dynamics of fly ash in water systems is important due to pollution of groundwater resources from toxic components such as trace metals. Other factors summarized are bioaccumulation and biomagnification, human health effects of contaminants, and the impact of radionuclides in fly ash. Future research needs should focus on reduction of the environmental impact of fly ash and increasing utilization of fly ash as a soil amendment. (Ver-Nooy-PTT)
W90-08238

GROUND WATER TRANSPORT OF HYDROPHOBIC ORGANIC COMPOUNDS IN THE PRESENCE OF DISSOLVED ORGANIC MATTER.
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
A. T. Kan, and M. B. Tomson.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 253-263, 1990. 3 fig, 2 tab, 47 ref. EPA Agreement No. CR-812808.

Descriptors: *Dissolved solids, *Groundwater movement, *Groundwater pollution, *Hydrophobic compounds, *Path of pollutants, DDT, Naphthalenes, Organic compounds, Phenanthrene, Soil columns, Sorption.

The effects of dissolved organic matter (DOM) on the transport of hydrophobic organic compounds in soil columns were investigated. Three compounds (naphthalene, phenanthrene and DDT) that

spanned three orders of magnitude in water solubility were used. Instead of humic matter, molecularly well-defined DOM represented by Triton X-100, a nonionic industrial detergent, and bovine serum albumin protein were used. In batch isotherm studies, the sorption of naphthalene to both model DOMs appeared to be hydrophobic in nature and quantitatively similar to the binding to humic materials. Equations were derived to model the enhanced transport of organic compounds by DOM based on octanol/water partition coefficients. For a specific soil and DOM level, it was shown theoretically and experimentally that all organic compounds with octanol/water partition coefficient values above a specific value should move at the same rate in ground water. In some situations, DOM can increase the movement of highly hydrophobic compounds, such as DDT, by a factor of a thousand or more. This enhanced transport in the presence of DOM can either be a problem, as with ground water contaminant spreading, or a benefit, as with contaminated aquifer cleanup. (Author's abstract)
W90-08239

FIELD RESEARCH ON ALDICARB MANAGEMENT PRACTICES FOR UPSTATE NEW YORK.
New York State Water Resources Research Inst., Ithaca.
For primary bibliographic entry see Field 5G.
W90-08241

CHARACTERIZATION OF THE REDUCING PROPERTIES OF ANAEROBIC SEDIMENT SLURRIES USING REDOX INDICATORS.
Environmental Research Lab., Athens, GA.
P. G. Tratnyek, and N. L. Wolfe.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 289-295, 1990. 3 fig, 2 tab, 21 ref.

Descriptors: *Anaerobic conditions, *Biodegradation, *Chemical reduction, *Fate of pollutants, *Indicators, *Oxidation-reduction potential, *Path of pollutants, *Sediments, *Slurries, Chemical reactions, Kinetics, Oxidation, Substrates.

Research on the reduction of organic pollutants in anaerobic environments is hampered by the complexity of the redox chemistry in natural systems. The reduction of six redox indicators in anaerobic sediment slurries were studied by observing the disappearance of the color of the oxidized forms. The reaction kinetics were first-order in concentration of the oxidized form of the indicator and the reducing agents were sediment associated. The rate of indicator reduction reflects the standard potential of the indicator couple, structure of the indicator moiety reduced and the potential and capacity of reducing agents in the sediment slurry. The relative reduction rates of the indicators suggest that anaerobic sediment systems contain concentrations of mild reducing agents that are available to react rapidly with substrates that are easily reduced. However, more refractory substrates require strong reducing agents that are gradually produced, probably as a result of microbial metabolism. (Author's abstract)
W90-08242

IDENTIFICATION OF AMMONIA AS AN IMPORTANT SEDIMENT-ASSOCIATED TOXICANT IN THE LOWER FOX RIVER AND GREEN BAY, WISCONSIN.
Environmental Research Lab.-Duluth, MN.
For primary bibliographic entry see Field 5C.
W90-08244

AMBIENT TOXICITY DYNAMICS: ASSESSMENTS USING CERIODAPHNIA DUBIA AND FATHEAD MINNOW (PIMEPHALES PROMELAS) LARVAE IN SHORT-TERM TESTS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W90-08248

Group 5B—Sources Of Pollution

ARSENIC UPTAKE AND TRANSFER IN A SIMPLIFIED ESTUARINE FOOD CHAIN.
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
D. M. Lindsay, and J. G. Sanders.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 391-395, 1990. 1 fig, 1 tab, 28 ref. EPA Grant X-003358.

Descriptors: *Arsenic, *Bioaccumulation, *Brine shrimp, *Food chains, *Path of pollutants, *Phytoplankton, Bioassay, Estuaries, Heavy metals, Tissue analysis, Water pollution effects.

Arsenic concentrations of freshwater and coastal bodies vary according to the amounts of arsenic added from anthropogenic sources and natural weathering. A simplified food chain of phytoplankton species, Artemia and Palaemonetes pugio was used to study pathways of arsenic uptake in estuarine ecosystems. Uptake of arsenic by phytoplankton was significant. Cellular contents increased from an arsenic content of 8.56 micrograms/g in the control cultures to 56.6 micrograms/g in cultures dosed with 25 micrograms/L. However, only small amounts (16.8 micrograms/g in controls to 17.8 micrograms/g at 25 micrograms arsenic/L) of arsenic were incorporated by Artemia, and no significant increases (p > 0.10) in arsenic content of P. pugio were found in those organisms exposed to arsenic-contaminated food or to elevated water concentrations. The lack of uptake by Artemia effectively ended the investigation of food chain transfer of arsenic at the second trophic level. Because the grass shrimp fed on a food source containing only slightly elevated arsenic levels, arsenic uptake through food at a higher trophic level could not be evaluated. (Author's abstract)
W90-08250

LEVELS OF PB, CR AND CD IN CALLINECTES SAPIDUS AND C. SIMILIS AND THEIR RELATION TO THE CONCENTRATION OF THESE METALS IN WATER AND IN SEDIMENT (NIVELES DE PB, CR Y CD EN CALLINECTES SAPIDUS Y C. SIMILIS Y SU RELACION CON LA CONCENTRACION DE ESTOS EN EL AGUA Y EN EL SEDIMENTO).
Universidad Autonoma Metropolitana, Mexico City. Lab. de Contaminacion, Bioensayos e Impacto Ambiental.
C. Rosas, T. Castaneda, G. Barrera, G. Negron, and S. Takagui.
Revista de Investigaciones Marines RIMAD2, Vol. 10, No. 1, p 71-88, 1989. 3 fig, 4 tab, 24 ref. English summary.

Descriptors: *Bioaccumulation, *Crabs, *Heavy metals, *Path of pollutants, Cadmium, Chromium, Coastal lagoons, Lead, Mexico, Sediment concentration.

Predicting the level of contamination that might result from exposure of an aquatic organism to trace metals is dependent upon a quantitative understanding of factors both external and internal to the organism. The determination of Pb, Cr and Cd was carried out in the water, sediment and crabs Callincetes sapidus and C. similus from the southern zone of Laguna de Tamiahua, Veracruz, Mexico. The influence of size (wet weight) on the metal concentration in crabs was reported. The analysis was carried out with a flameless atomic absorption spectrophotometer. Both salinity-dependent variability and regional variations of metal concentrations in water, sediments and crabs were observed. Water metal concentrations were higher than those permitted by Mexican legislation for coastal lagoons. In contrast, sediment metal concentrations were lower than metal concentrations in industrialized areas. The results were analyzed in relation to size, water and sediment metal concentrations and distribution within the coastal lagoon. (Author's abstract)
W90-08281

COMPARATIVE METABOLISM OF BENZO(A)PYRENE BY LIVER MICROSOMES FROM BROWN BULLHEAD AND CARP.
State Univ. of New York Coll. at Buffalo. Great Lakes Lab.

H. C. Sikka, J. P. Rutkowski, and C. Kandaswami.
Aquatic Toxicology AQTODG, Vol. 16, No. 2, p 101-111, March 1990. 2 fig, 2 tab, 26 ref. EPA Grant R-813799.

Descriptors: *Benz(a)pyrene, *Bullhead, *Carcinogens, *Carp, *Fate of pollutants, *Fish physiology, *Liver, *Metabolism, Comparison studies, Metabolites, Structure-activity relationships.

The metabolism of the carcinogenic benzo(a)pyrene (BP) by hepatic microsomes was examined in untreated bullhead (Ictalurus nebulosus) and mirror carp (Cyprinus carpio), two bottom dwelling fish species. The rate of metabolism of BP by carp liver microsomes (455.1 +/- 141.5 picomoles per minute per milligram of protein (pmol/min/mg)) was considerably higher than that obtained with bullhead liver microsomes (38.1 +/-12.3 pmol/min/mg protein). The major BP metabolites formed by liver microsomes from both species were qualitatively similar and included BP-7,8-diol, BP-9,10-diol, 3-hydroxy-BP, 9-hydroxy-BP, BP-1,6-quinone, BP-3,6-quinone, and BP-6,12-quinone. However, the patterns of BP metabolites generated by the liver microsomes of the two species were considerably different from each other. The carp liver microsomes converted a much greater proportion of BP to benzo-ring dihydrodiols than did the bullhead liver microsomes. Compared to carp liver microsomes, bullhead liver microsomes formed a considerably higher percentage of BP-phenols and BP-quinones as a fraction of the total metabolites. The predominant enantiomer of BP-7,8-diol formed by liver microsomes of both species had an (-)R,R absolute stereochemistry, suggesting a similar stereoselectivity in the metabolism of BP to BP-7,8-diol by both carp and bullhead liver microsomes. (Author's abstract)
W90-08285

COMPARATIVE ACCUMULATION OF COBALT BY THREE CRUSTACEANS: A DECAPOD, AN AMPHIPOD, AND A BARNACLE.
Queen Mary Coll., London (England). School of Biological Sciences.
P. S. Rainbow, and S. L. White.
Aquatic Toxicology AQTODG, Vol. 16, No. 2, p 113-126, March 1990. 2 fig, 8 tab, 15 ref. NREC Grant GR3/5256.

Descriptors: *Amphipods, *Barnacles, *Bioaccumulation, *Cobalt, *Crustaceans, *Fate of pollutants, *Grass shrimp, Cadmium, Comparison studies, Heavy metals, Radioactive tracers, Zinc.

The comparative accumulation of the essential heavy metal cobalt from solution by three different littoral crustaceans was studied under standardized physicochemical conditions. The crustaceans under study were the caridean decapod Palaemon elegans, the amphipod Echinogammarus pirloti, and the barnacle Elminius modestus. All three crustaceans showed linear net accumulation of cobalt from solution over a wide range of dissolved radioactively labeled cobalt concentrations, with no significant excretion of accumulated cobalt during the time period of the experiments. Thus in all three species the newly accumulated labeled cobalt concentration was equivalent to the increase in concentration of total body cobalt. The apparent ability of decapod crustaceans to regulate the body concentrations of the essential metals copper and zinc is therefore not extended to all essential trace metals. There are interspecific differences in rates of cobalt uptake, being lowest in the decapod and similar in the amphipod and barnacle. Calculations of a molar index of metal uptake show that cobalt is taken up at a lower rate than cadmium which in turn is taken up more slowly than zinc in all three crustaceans. (Author's abstract)
W90-08286

PHARMACOKINETIC MODEL FOR THE DISPOSITION OF POLYCHLORINATED BIPHENYLS (PCBS) IN CHANNEL CATFISH.
Northeast Louisiana Univ., Monroe. Div. of Pharmaceutics and Medicinal Chemistry.
M. G. Kulkarni, and A. H. Karara.
Aquatic Toxicology AQTODG, Vol. 16, No. 2, p 141-150, March 1990. 3 fig, 2 tab, 39 ref.

Descriptors: *Catfish, *Fish, *Path of pollutants, *Polychlorinated biphenyls, Computer models, Kinetics, Radioactive tracers, Simulation analysis.

Channels catfish, Ictalurus punctatus, acclimated to 18 C, with mean body weight of 0.36 kilogram, were fitted with a cannula in the dorsal aorta. An intraaortic bolus injection of 50 micrograms per kilogram C-14 polychlorinated biphenyls (PCBs)(42% w/w chlorine) was administered to five fish. Blood samples were withdrawn up to 96 hours post injection. The blood concentration time course showed a triexponential decline with a rapid initial distributive phase and a slow terminal elimination phase. A three compartment model comprising a central, shallow peripheral, and deep peripheral compartment adequately described the kinetics of PCBs in catfish. The whole body clearance was estimated to be 19.6 milliliters per hour per kilogram and the volume of distribution at steady state was 1196.8 milliliters per kilogram. The terminal elimination half-life of PCBs in catfish was found to be 55.9 hours. Computer based simulations based on the developed model indicated that the majority of PCBs in the fish are associated with tissues of the deep peripheral compartment (i.e. adipose tissue). (Author's abstract)
W90-08288

IMPACT OF DIFFUSE NITRATE POLLUTION SOURCES ON GROUNDWATER QUALITY--SOME EXAMPLES FROM CZECHOSLOVAKIA.
Stavebni Geologie, Prague (Czechoslovakia). Hydrogeology Dept.
For primary bibliographic entry see Field 4C.
W90-08295

GROUNDWATER POLLUTION BY NITRATES FROM LIVESTOCK WASTES.
Vsesoyuznyi Nauchno-Issledovatel'skii Inst. Gidrogeologii i Inzhenerdoi Geologii, Moscow (USSR).
V. M. Goldberg.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 25-29, November 1989. 2 tab, 13 ref.

Descriptors: *Farm wastes, *Groundwater pollution, *Nitrates, *Path of pollutants, *Wastewater irrigation, Ammonium, Geohydrology, Permeability, Soil properties, Water pollution sources.

Utilization of wastes from livestock complexes for irrigation involves the danger of groundwater pollution by nitrates. In order to prevent and minimize pollution, it is necessary to apply geological-geohydrological evidence and concepts to the situation of wastewater irrigation for the purposes of studying natural groundwater protectiveness and predicting changes in groundwater quality as a result of infiltrating wastes. The main factor of groundwater natural protectiveness or the main geological feature that protects the aquifer is the presence of overlying semipermeable deposits. Deposits are considered semipermeable if their permeability coefficient is < 0.1 m/day. Loamy sands, sands with clay, and clays are soil types that belong to this category. The first step in determining the protectiveness of a particular aquifer is to assign numerical values for important aquifer characteristics. Then these individual contributions are added together to give a cumulative sum. The greater the magnitude of the sum, the higher the protectiveness of the aquifer. The complex of features characterizing the conditions of groundwater protectiveness are as follows: depth of groundwater table (or thickness of the zone of aeration); thickness of semipermeable deposits in the profile of the zone of aeration; and lithology and permeability properties of semipermeable deposits (lithology and permeability properties are interrelated). With groundwater pollution by nitrate nitrogen, the concentration of ammonium nitrogen noticeably increases. One of the reasons for this change is the process of denitrification due to changes in the geohydrochemical conditions in a layer. At representative field sites, it is necessary to collect systematic stationary observations of the concentrations of nitrogenous compounds in groundwater

and changes in redox conditions and temperature. (Author's abstract)
W90-08296

CHEMICAL SUBSTANCE TRANSPORT IN SOILS AND ITS EFFECT ON GROUNDWATER QUALITY.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
M. G. Khublarian.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 31-37, November 1989. 1 fig, 20 ref.

Descriptors: *Groundwater quality, *Model studies, *Path of pollutants, *Soil water, Agricultural runoff, Geohydrology, Pesticides, Salinity, Soil properties, Water pollution sources.

The main sources of groundwater contamination are municipal, industrial, and agricultural wastes (both solid and liquid), gangue rocks, sludge and slimes, refuse, pesticides, herbicides, effluents from livestock and poultry farms. Pollutants have different migration capacities, toxicities, and other properties. In the USSR, chemical methods are used to protect agricultural areas and forests from pests and undesirable plants. In 1986, 20 million ha were treated with pesticides, while biological methods were applied only on small areas. Many of these pesticides contain heavy metals, such as As, Hg, Cd, Pb and Cu, which are toxic at even low concentrations. Farm wastes, consisting mainly of nitrogen, phosphorus, and potassium, are also common in the USSR. Field observations in one region of the USSR show that from 1980 to 1985, a loam layer 140 cm deep retained 82.4% of ammonia nitrogen, 90.3% of phosphates, 30% of total nitrogen, and 90% of potassium contained in the effluents. In this paper, a brief estimation of groundwater salinity is given for various regions of the USSR where irrigation is practiced, as well as their experience in environmental protection. Special attention is given to methods of simulating water seepage and chemical substance transport in soils. Boundary problems for free-surface seepage and dissolved solids and chemical substance transport in porous media are stated, and methods of solution are described in an example of the hydrodynamic theory of seepage and dispersion. These hydrodynamic substance transport models are able to examine a large number of geohydrological settings, making it possible to determine exposure concentrations of toxic chemicals in drinking waters derived from groundwater for many combinations of system parameters. These models also make it possible to examine the impact on groundwater quality of agricultural practices and waste management activities by taking into account the interaction of geohydrological characteristics of the subsurface and the chemical properties of the pollutant. (Author's abstract)
W90-08297

PRINCIPLES AND PROBLEMS OF ENVIRONMENTAL POLLUTION OF GROUNDWATER RESOURCES WITH CASE EXAMPLES FROM DEVELOPING COUNTRIES.

Anambra State Univ. of Technology, Enugu (Nigeria). Dept. of Geological Sciences.
B. C. E. Egboka, G. I. Nwankwor, I. P. Orajaka, and A. O. Ejiofor.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 39-68, November 1989. 17 fig, 8 tab, 91 ref.

Descriptors: *Developing countries, *Literature review, *Water pollution sources, *Water quality control, Brazil, Case studies, Geohydrology, India, Kenya, Nigeria, Rural areas, Urban areas.

The principles and problems of environmental pollution and contamination are reviewed with emphasis on case examples from developing countries of Africa, Asia, and Latin America, comparing them to developed countries. The problems of pollution and contamination are widespread in developed countries but are gradually spreading from the urban to rural areas in the developing countries. Great efforts in research and control programs to check pollution-loading into the environment have been made in the industrialized coun-

tries, but only negligible actions have been taken in developing countries. Pollutants emanate from both point and distributed sources, and adversely affect both surface water and groundwaters. The influences of the geologic and hydrologic cycles that exacerbate the incidences of pollution and contamination have not been well understood by environmental planners and managers. Professionals in the different areas of pollution control projects, particularly in developing countries, lack the integrated multiobjective approaches and techniques in problem solving. Such countries as Nigeria, Kenya, Brazil, and India are now menaced by pollution hazards. Appropriate methods of control are suggested at the conclusion of this review. (Author's abstract)
W90-08298

PREDICTION OF CONTAMINANT RETENTION AND TRANSPORT IN SOILS USING KINETIC MULTIREACTION MODELS.

Louisiana State Univ., Baton Rouge.
H. M. Selim.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 69-75, November 1989. 7 fig, 2 tab, 47 ref. Louisiana Agricultural Experiment Station Project 2469.

Descriptors: *Kinetics, *Model studies, *Path of pollutants, *Soil properties, Mathematical models, Soil contamination, Solute transport.

An overview of several models that are used for the description of the retention of dissolved chemicals during transport in the soil profile is presented. Single reaction models were classified into equilibrium and kinetic types. In addition, an equilibrium and kinetic two-site model of the nonlinear type was presented. Major advantages of this combination type model over the single reaction approach were outlined and several solute breakthrough curves illustrated. Furthermore, a generalized form of a multireaction kinetic model was given. The major feature of multireaction kinetic models is that they are flexible, being neither restricted by the number of solute species present in the soil system nor by the governing retention reaction mechanisms. Such models may include reversible and irreversible reactions of the linear and nonlinear kinetic types. Moreover, these models can incorporate concurrent as well as consecutive-type retention reactions that may be equilibrium or kinetic in nature. Rigorous validation of such models is needed for various contaminants and for soils having different physical and chemical properties. Model validation is a prerequisite step before model adoption as a predictive tool of the potential mobility of contaminants in soils. (Author's abstract)
W90-08299

HYDROGEOLOGICAL ROLE OF AN AQUITARD IN PREVENTING DRINKABLE WATER WELL CONTAMINATION: A CASE STUDY.

Milan Univ. (Italy). Dipt. di Scienze della Terra.
G. Ponzini, G. Crosta, and M. Giudici.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 77-95, November 1989. 18 fig, 2 tab, 15 ref.

Descriptors: *Aquitards, *Groundwater movement, *Groundwater pollution, *Path of pollutants, Aquifer systems, Aquifers, Case studies, Mathematical models, Model studies, Vertical flow.

In order to evaluate the risk of aquifer contamination, a model of the aquifer is needed. In this paper, a quasi-tridimensional model is described and applied to a multilayered aquifer where a phreatic aquifer was coupled to a confined one by means of an aquitard. This geohydrological scheme is often met in practice and, therefore, models a number of situations. Moreover, aquitards play an important role in the management of natural resources of this kind. The model adopted contains some approximations: the flow within the aquifers is assumed to be horizontal, whereas leakage is assumed vertical. The effect of some wells drilled in these aquifers is also taken into account. In order to evaluate the leakage fluxes that correspond to different exploi-

tation conditions, a system of quasilinear and time-dependent partial differential equations was numerically solved. The model has been calibrated with geohydrological data from a water supply station of the Milan Water Works, where water is polluted by several halocarbons. The simulations account for several experimental facts, both from the geohydrological and geohydrochemical points of view. Maxima of computed downward leakage rates are found to correspond with measured pollutant concentration maxima. Evidence is produced against the widespread, and often unjustified, remedy of letting all wells in a contaminated area continuously discharge for a long time--even years--in order to expel pollutants from the aquifer. This method is shown to be either counterproductive or ineffective in the coupled aquifer system the models simulate. Another advantage of the model appears to be its ability to determine the optimal pumping pattern and schedule (which minimizes the transport of contaminants toward the confined aquifer) given the needed total discharge rate. (Author's abstract)
W90-08300

APPLICATIONS OF NUMERICAL METHODS TO SIMULATE THE MOVEMENT OF CONTAMINANTS IN GROUNDWATER.

Shandong Univ., Jinan (China). Environmental Science Center.
N. Z. Sun.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 97-115, November 1989. 5 fig, 1 tab, 156 ref.

Descriptors: *Groundwater pollution, *Literature review, *Mathematical models, *Mathematical studies, *Path of pollutants, Advection, Finite difference methods, Finite element method, Groundwater movement, Model studies.

This paper reviews mathematical models and numerical methods that have been extensively used to simulate the movement of contaminants through the subsurface. The major emphasis is placed on the numerical methods of advection-dominated transport problems and inverse problems. Several mathematical models that are commonly used in field problems are listed. A variety of numerical solutions for three-dimensional models are introduced, including the multiple cell balance method that can be considered a variation of the finite element method. The multiple cell balance method is easy to understand and convenient for solving field problems. When the advection transport dominates the dispersion transport, two kinds of numerical difficulties, overshoot and numerical dispersion, are always involved in solving standard, finite difference methods and finite element methods. To overcome these numerical difficulties, various numerical techniques are developed, such as upstream weighting methods and moving point methods. A complete review of these methods is given with mention of the problems of parameter identification, reliability analysis, and optimal-experiment design that are absolutely necessary for constructing a practical model. (Author's abstract)
W90-08301

MODELING MULTIPHASE MIGRATION OF ORGANIC CHEMICALS IN GROUNDWATER SYSTEMS--A REVIEW AND ASSESSMENT.

Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
L. M. Abriola.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 117-143, November 1989. 7 fig, 162 ref. EPRI Contract RP 2377-5 and NSF Grant ECE-8451469.

Descriptors: *Groundwater movement, *Literature review, *Model studies, *Multiphase flow, *Organic compounds, *Path of pollutants, Capillarity, Groundwater pollution, Mathematical equations, Mathematical models.

Over the past two decades, a number of models have been developed to describe the multiphase migration of organic chemicals in the subsurface. This review presents the state-of-the-art with

regard to such modeling efforts. The mathematical foundations of these models are explored and individual models are presented and discussed. Models are divided into three groups: (a) those that assume a sharp interface between the migrating fluids; (b) those that incorporate capillarity; and (c) those that consider interphase transport of mass. Strengths and weaknesses of each approach are considered along with supporting data for model validation. Future research directions are also highlighted. (Author's abstract)
W90-08302

ADSORPTION OF ORGANIC CHEMICALS IN SOILS.
Institut National Agronomique Paris-Grignon (France). Lab. des Sols.
R. Calvet.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 145-177, November 1989. 20 fig, 24 tab, 192 ref.

Descriptors: *Adsorption, *Literature review, *Organic compounds, *Path of pollutants, *Soil contamination, Chemical interactions, Soil chemistry, Soil properties.

The adsorption of organic chemicals on soils sediments and their constituents is reviewed. The first part of this review deals with adsorption from gas and liquid phases and discusses the physical meaning of the shape of adsorption isotherms. No general rules can be proposed to describe univocally the relation between the shape of isotherms and the nature of the adsorbate-adsorbent system. Kinetics of adsorption is discussed through the description of various models. Theoretical developments exist both for the thermodynamics and the kinetics of adsorption, but there is a strong need for experimental results. Possible adsorption mechanisms are ion exchange, interaction with metallic cations, hydrogen bonds, charge transfers, and London-van der Waals dispersion forces/hydrophobic effect. However, direct proofs of a given mechanism are rare. Several factors influence adsorption behavior. Electronic structure of adsorbed molecules, properties of adsorbents, and characteristics of the liquid phase are discussed in relation to adsorption. Such properties as water solubility, organic carbon content of adsorbing materials, and the composition of the liquid phase are particularly important. Evaluation of adsorption can be obtained through either laboratory measurements or use of several correlations. Adsorption measurements must be interpreted, taking into account treatment of adsorbent materials, experimental conditions, and secondary phenomena such as degradations. Correlations between adsorption coefficients and water-octanol partition coefficients, or water solubility, are numerous. They may be useful tools for prediction purposes. Relations with transport, bioavailability, and degradation are described. (Author's abstract)
W90-08303

QUANTITATIVE MODELING OF SOIL SORPTION FOR XENOBIOTIC CHEMICALS.
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Theoretical Chemistry Group.
A. Sabljic.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 179-190, November 1989. 1 fig, 5 tab, 63 ref.

Descriptors: *Mathematical models, *Organic compounds, *Path of pollutants, *Soil chemistry, *Soil contamination, *Sorption, Hydrocarbons, Mathematical equations, Model studies, Soil properties.

Since an estimated 100,000 chemicals are currently in common use and new chemicals are registered at a rate of 1000 per year, it becomes apparent that human and material resources are insufficient to experimentally obtain their soil sorption data. Empirical models, based on water solubility and n-octanol/water partition coefficients, have been proposed as alternative, accurate methods to estimate soil sorption coefficients. An analysis of the models has shown: (a) low precision of water solubility and n-octanol/water partition data, (b) varieties of quantitative models describing the rela-

tionship between the soil sorption and above-mentioned properties, and (c) violations of some basic statistical laws when these quantitative models were developed. Following 5 years of developing error-free, empirical models molecular topology appears to be the most successful structural property for describing and predicting soil sorption coefficients. The first-order molecular connectivity index was demonstrated to correlate extremely well with the soil sorption coefficients of polycyclic aromatic hydrocarbons (PAHs), alkylbenzenes, chlorobenzenes, chlorinated alkanes and alkenes, heterocyclic and heterosubstituted PAHs, and halogenated phenols. The average difference between predicted and observed soil sorption coefficients is only 0.2 on the logarithmic scale (corresponding to a factor of 1.5). A comparison of the molecular connectivity model with the empirical models shows that the former is superior in accuracy, performance, and range of applicability. It is possible to extend this model, with the addition of a single, semiempirical variable, to take care of polar and ionic compounds, and to accurately predict the soil sorption coefficients for almost 95% of all organic chemicals whose coefficients have been reported. An additional advantage of the molecular connectivity model is that it is sufficient to know the structural formulas to make predictions about soil sorption coefficients. Structural analysis of the quantitative model has shown that two factors are responsible for the majority of the variations in the soil sorption data: the molecular surface areas and the polarity of compounds. (Author's abstract)
W90-08304

APPLICATION OF A MEMBRANE MODEL TO THE SORPTIVE INTERACTIONS OF HUMIC SUBSTANCES.
Geological Survey, Arvada, CO.
R. L. Wershaw.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 191-203, November 1989. 4 fig, 1 tab, 81 ref.

Descriptors: *Chemical interactions, *Membrane processes, *Model studies, *Organic matter, *Path of pollutants, *Sorption, Chemical reactions, Humic substances, Inorganic compounds, Metals, Organic compounds.

Humic substances, the dark-colored, natural organic polyelectrolytes that are found in practically all soils, sediments, and natural water, strongly interact with both inorganic and organic pollutants. Inorganic cationic species generally undergo complexation reactions with humic substances. The binding of cations, such as cupric ions, by humic substances often markedly reduces their toxicity to aquatic organisms. Some inorganic anionic species, in the presence of metal ions, are sorbed by humic substances. In these instances the metal ions appear to form bridges between the humic substances and the anions. Several different types of interactions take place between organic compounds and humic materials. Hydrophobic organic species partition into either insoluble or soluble humic substances. The insoluble humic substances will remove hydrophobic organic compounds from the aqueous phase, thereby rendering them less mobile. However, soluble humic substances will solubilize hydrophobic organics, increasing their mobility. Other types of interactions between humic substances and organic compounds, such as adsorption and ion exchange, also have been observed. These various interactions between humic substances and pollutants are important in governing their fate and movement in natural water systems, and, for this reason, a detailed understanding of the mechanisms of the interaction is important. Many of these interactions can be rationalized using the membrane or micelle model. However, in order to extend this model to allow us to make useful predictions will require it to be incorporated with a generalized transport model such as one of the multimedia transport models. (Author's abstract)
W90-08305

CHEMICAL REACTIONS OF ORGANIC COMPOUNDS ON CLAY SURFACES.
National Inst. for Environmental Studies, Ibaraki

(Japan).
Y. Soma, and M. Soma.
Environmental Health Perspectives EVHPAZ, Vol. 83, p 205-214, November 1989. 2 fig, 86 ref.

Descriptors: *Chemical reactions, *Clays, *Fate of pollutants, *Organic compounds, *Pesticides, Biodegradation, Chemical degradation, Chemical interactions, Hydrolysis, Microbial degradation, Path of pollutants.

The environmental aspects of organic compounds chemically reacting on clay surfaces relate to those in soils. Three main types of the transformation of organic compounds in soils are considered: photodecomposition, chemical transformation, and microbiological degradation. Although simultaneous chemical and microbiological transformations in soils are difficult to distinguish, it is generally accepted that the degradation of most organic compounds in soils involves microorganisms because the sterilization of soils greatly reduces the rate of degradation of many chemicals. Clay minerals act as Bronsted acids or Lewis acids for organic molecules. This property is derived from the minerals' characteristic structures. Various kinds of reactions for alkenes and dehydration of alcohols occur on clay minerals under moderate reaction conditions. These reactions proceed catalytically on Bronsted acid sites on clay minerals. The geometrical constraints imposed by the structure of clay minerals result in increased specificity of the reaction. Hydrolysis of organophosphorus pesticides is enhanced on kaolinite, and the rate of hydrolysis is affected by the Bronsted acidity, controlled by the hydration status of the clay. Lewis acid sites on clays, which are interlayer transition-metal ions and Al or Fe atoms at crystal edges, oxidize various kinds of aromatic molecules in moderate reaction conditions to form their cation radicals. Oligomerization or polymerization proceeds through the aromatic cation radical formed. Aromatic amines and phenols that have low ionization potentials can be easily oxidized on clays; these reactions may proceed chemically in soils. Soil humic matter also participates in the chemical transformation of organic compounds in soil. (Author's abstract)
W90-08306

CHANGES IN BIOLOGICALLY CONTROLLED CARBON FLUXES IN A SMALL STREAM FOLLOWING CONTINUOUS SUPPLY OF EXCESS ORGANIC LOAD.
Universite de Savoie, Chambery (France). Lab. d'Ecologie.
D. Fontvieille, and B. Cazelles.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 123-141, March 15, 1990. 18 fig, 2 tab, 45 ref.

Descriptors: *Farm wastes, *Organic loading, *Streams, *Water pollution effects, *Water pollution sources, Biological properties, Biomass, Ecological effects, Macroinvertebrates, Microorganisms, Organic carbon.

The consequences of a constant supply of organic load from a pigsty to a small 2nd order stream are analyzed through simultaneous consideration of amount of carbon stored in benthic biomass and of main biologically controlled carbon fluxes. The results show that the allochthonous load induced a general increase in all fluxes and therefore stimulated processes of carbon elimination from the receiving system. The increase of biologically controlled fluxes was due to qualitative changes of populations toward specialization for an optimal use of the newly supplied organic substrates. This was especially evident in this stream for macro-invertebrate biomass production and for insect emergence. Effects of trophic pollution ranged from drastic modifications near the input of the pig waste to a place where the additional supply of organic substrate increased the numbers of individuals of macroinvertebrate populations without any change in their specific diversity. Variations of CO_2 production appeared to be more related to biomass of microbial populations in the downstream station and to macroinvertebrates in the upstream station. Although the allochthonous load caused significant increases in several processes

involved in its own elimination, the magnitude of these increases was small compared to the influx of organic carbon from upstream and from the pigsty. (Author's abstract)
W90-08307

HEAVY METAL CONTENT OF SEDIMENTS IN THE CALCASIEU RIVER/LAKE COMPLEX, LOUISIANA.

McNeese State Univ., Lake Charles, LA. Dept. of Chemistry.
J. N. Beck, G. J. Ramelow, R. S. Thompson, C. S. Mueller, and C. L. Webre.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 149-165, March 5, 1990. 12 fig, 4 tab, 13 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Calcasieu Lake, *Heavy metals, *Lake sediments, *Limnology, *Louisiana, *Sediment contamination, *Sediment distribution, *Sediment transport, *Water pollution sources, Arsenic, Bottom currents, Cadmium, Calcasieu River, Chromium, Copper, Erosion, Lake Erken, Lake Tamnaren, Lake Valloxen, Lead, Mercury, Path of pollutants, Sedimentation, Shear stress, Silver, Storms, Suspended solids, Sweden, Zinc.

The heavy metals Cd, Cr, Cu, Pb, Hg, Ag, and Zn, and the metalloid As were measured in surface sediments at permanent stations located in the Calcasieu River/Lake Complex. The relationships among metal concentrations in different areas of the system were investigated to determine sources, source strength, and transport. The point-source inputs of heavy metals were assumed to be industrial outfalls (Bayou d'Inde) and sewage outfalls (Bayou d'Inde and Contraband Bayou). Although these inputs have not seriously affected the entire river/lake system, stressed regions exist within each bayou. The background levels of arsenic and heavy metals were: 0.60 (As), 0.3 to 1.4 (Cd), 25 (Cr), 10 (Cu), 15 (Pb), <0.05 (Hg), 0.07 (Ag), and 40 mg/kg (Zn). Stations near sewage outfalls and industrial outfalls had increased metal concentrations above these background levels, but the increases were restricted to the regions near the outfalls. The metals discharged into the bayous were not being transported to the remainder of the river/lake complex. (Author's abstract)
W90-08309

ANALYSIS OF SOLUTE TRANSPORT WITH A HYPERBOLIC SCALE-DEPENDENT DISPERSION MODEL.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
S. Mishra, and J. C. Parker.
Hydrological Processes HYPRE3, Vol. 4, No. 1, p 45-57, January/March 1990. 12 fig, 1 tab, 14 ref. Electrical Power Research Institute, Solid Waste Environmental Studies Program contract number RP2485-06.

Descriptors: *Dispersivity, *Groundwater movement, *Groundwater pollution, *Model studies, *Path of pollutants, *Solute transport, Aeration zone, Dispersion coefficient, Least squares method, Numerical analysis, Tracers, Unsaturated flow.

Concerns with groundwater contamination have focused attention on the development of accurate models for the prediction of subsurface pollutant transport. An empirical hyperbolic scale-dependent dispersion model, which predicts a linear growth of dispersivity close to the origin and the attainment of an asymptotic dispersivity at large distances, is presented for deterministic modeling of field-scale solute transport and the analysis of solute transport experiments. A simple relationship is derived between local dispersivity, which is used in numerical simulations of solute transport, and effective dispersivity, which is estimated from the analysis of tracer breakthrough curves. The scale-dependent dispersion model is used to interpret a field tracer experiment by nonlinear least squares inversion of a numerical solution for unsaturated transport. Simultaneous inversion of concentration-time data from several sampling locations indicates a linear growth of the dispersion process over the scale of the experiment. These findings are consist-

ent with the results of an earlier analysis based on the use of a constant dispersion coefficient model at each of the sampling depths. (Author's abstract)
W90-08327

CHARACTERISTICS OF SUSPENDED SEDIMENT IN THE UPPER RHONE RIVER, SWITZERLAND, INCLUDING THE PARTICULATE FORMS OF PHOSPHORUS.

Geneva Univ. (Switzerland). Inst. F.-A. Forel.
D. Burrus, R. L. Thomas, B. Dominik, J. P. Vernet, and J. Dominik.
Hydrological Processes HYPRE3, Vol. 4, No. 1, p 85-98, January/March 1990. 5 fig, 10 tab, 19 ref.

Descriptors: *Nutrient transport, *Path of pollutants, *Phosphorus, *Rhone River, *Sediment transport, *Solute transport, *Suspended sediments, *Switzerland, Geochemistry, Lake Geneva, Organic matter, Particulate matter, Phosphorus compounds, Primary productivity, River flow, Seasonal variation, Trace elements, Trace metals, Turbidity flow, Wastewater treatment facilities.

Studies of the role of sediment in the transport of nutrients and toxic contaminants in the aquatic environment have demonstrated the need for comprehensive chemical and physical analyses of suspended particulates. Six stations along the Upper Rhone River above Lake Geneva, Switzerland, were sampled for recovery of suspended sediment; for a number of major elements; for trace elements; for Organic C and Kjeldahl N; and the forms of phosphorus bound as Organic P (OP), Apatite P (AP), and Non Apatite Inorganic P (NAIP). The major elements and trace metals confirmed that there is virtually no change in the major geochemical characteristics of the suspended solids in the Rhone, spatially or temporally, indicating that the river is a well mixed sedimentary system. AP also remained constant in concentration throughout the year. Sediment recovered during the winter low flow, low turbidity period has been designated SED 1, whereas sediment from the high flow, high turbidity summer condition has been designated SED 2. Organic C, OP, and NAIP show a dramatic decrease in concentration from SED 1 to SED 2, ascribed to dilution of a relatively constant supply of organic matter and phosphorus derived mainly from sewage treatment plants, resulting in variable partitioning of the OP/NAIP and Organic C under the different turbidity condition in the river between winter and summer. This interpretation is confirmed by a low and consistent C-N ratio. The low values of estimated proportion of particulate bio-available phosphorus would suggest that there would be no observable effect on the primary production of the receiving waters of Lake Geneva, which would thus respond only to the cumulative loading of phosphorus from the Rhone River. (Author's abstract)
W90-08330

SIMULATION OF CHEMICAL TRANSPORT IN UNSATURATED SOIL.

Bechtel Environmental, Inc., Oak Ridge, TN.
S. Nair, D. Longwell, and C. Seigneur.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 214-235, March/April 1990. 18 fig, 3 tab, 22 ref.

Descriptors: *Hazardous waste disposal, *Model studies, *Path of pollutants, *Solute transport, Aeration zone, Air-earth interfaces, Air-water interfaces, Benzene, Diffusion, Earth-water interfaces, Environmental engineering, Equilibrium, Finite difference method, Finite element method, Leaching, Risk assessment, Soil water, Sorption, Volatile organic compounds.

The extent of a remedial action at a hazardous waste site is generally determined by means of a risk assessment, requiring knowledge of toxic contaminant concentrations in the atmosphere and groundwater downstream of the waste site. A one-dimensional three-phase solute transport model was developed to simulate the vertical movement of contaminants in the unsaturated region above the water table. The solute transfer across the air-water, water-solid, and air-solid interfaces was modeled using sorption-equilibrium assumption at

the interfaces. The sequential iteration approach has been used to split the transport and equilibrium parts of the governing equations, which are solved using a combined modified Galerkin finite element and Crank-Nicolson finite difference scheme. The model was used to predict the transient gas-phase solute emission rate to the atmosphere and the liquid-phase leach rate into the groundwater. Two retardation factors were developed for the gas-phase and aqueous-phase transport in the unsaturated zone. For volatile compounds like benzene, neglecting the gas-phase diffusion in the unsaturated zone can result in the underestimation of their leach rates to the groundwater. (Author's abstract)
W90-08340

AUTOMATED CALIBRATION AND USE OF STREAM-QUALITY SIMULATION MODEL.

CH2M Hill, Inc., Atlanta, GA.
D. M. Wood, M. H. Houck, and J. M. Bell.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 236-249, March/April 1990. 8 fig, 13 ref.

Descriptors: *Biochemical oxygen demand, *Computer models, *Environmental engineering, *Expert systems, *Model studies, *Simulation analysis, *Stream pollution, *Water pollution control, *Water quality, Calibrations, Recreation, Stream improvement, Water supply.

The quality of streamwater is directly affected by the amount of waste discharged into the stream, and this quality governs the extent to which the water can be used for other purposes, such as recreation or water supply. To understand and manage the stream, it is often helpful to construct simulation models of the water quality. Among the more promising enhancements of simulation methods has been the incorporation of artificial intelligence, or expert systems technology. An expert system technology has been developed to aid in the calibration process and subsequent use of a stream-quality simulation model. An expert system shell, called KES, is used to facilitate the fast and efficient development and testing of the expert system. A biochemical oxygen demand-dissolved-oxygen model, graphics software, and a program to perform model calibration are all linked externally to the shell. The user of the expert system is queried for field data necessary for calibration of the stream-quality model, and is then provided with advice and instructions for performing the calibration and using the simulation model. The real strength of this package is that it brings together all the separate entities of the modeling process and offers related expert advice to the user. (Author's abstract)
W90-08341

STATISTICAL EVALUATION OF MECHANISTIC WATER-QUALITY MODELS.

Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
K. H. Reckhow, J. T. Clements, and R. C. Dodd.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 250-268, March/April 1990. 4 fig, 4 tab, 14 ref.

Descriptors: *Model studies, *Simulation analysis, *Statistical analysis, *Statistical methods, *Water quality, Environmental engineering, Model testing, Regression analysis.

Current practice for the verification of water-quality simulation models is to use a combination of modeler judgment and graphical analysis to assess the adequacy of a model. Statistical testing of goodness-of-fit is sometimes undertaken, but usually with a null hypothesis that does not allow distinction between acceptable fit and highly variable data. Statistical methods are proposed to augment, but not replace, this conventional approach with a quantitative expression of goodness-of-fit. Model verification is expressed as a problem in hypothesis testing that may be conducted using a variety of statistical methods. The null hypothesis must be structured so that good model fit is not confounded with highly variable predictions and observations. The proposed methods of hypothesis

testing are based on assumptions concerning the data and the distributions; in some cases, these assumptions may be safely ignored and in other cases they can have a substantial impact on test results. The t-test, the Wilcoxon test, regression analysis, and the Kolmogorov-Smirnov test are applied for verification of mechanistic water-quality models, resulting in more rigorously tested models in the long run. (Author's abstract)
W90-08342

STOCHASTIC SYSTEM IDENTIFICATION OF SEWER-FLOW MODELS.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-08344

EFFECTS OF BENTHIC FLORA ON ARSENIC TRANSPORT.
Geological Survey, Menlo Park, CA. Water Resources Div.
J. S. Kuwabara, C. C. Y. Chang, and S. P. Pasilis.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 394-409, March/April 1990. 6 fig, 3 tab, 24 ref.

Descriptors: *Arsenic compounds, *Benthic flora, *Path of pollutants, *Solute transport, *Stream pollution, Absorption, Accumulation, Algae, Diatoms, Environmental engineering, Isolation, Mine wastes, Phosphates, South Dakota, Standing crops.

Chemical and biological interactions involving arsenic (As) and phosphorus (P) appear to affect significantly As transport and distribution in Whitewood Creek, South Dakota. Data (first-order uptake rate constants, standing crop, and accumulation factors) that can be used to predict As transport have been determined using algae collected in the creek along a transect from upstream of mine discharge downgradient through a 57-km impacted reach. Cultures of Achnanthes minutissima (Bacillariophyceae) were isolated from four sites along a longitudinal gradient of dissolved As within the study reach and were maintained at ambient dissolved-As concentrations. As sorption rate constants for cell surfaces of these isolates were estimated as a function of dissolved arsenate and orthophosphate. All isolates sorbed orthophosphate preferentially over arsenate. Initial sorption of both arsenate and orthophosphate appeared to follow a first-order equation within media formulations but did not adequately describe other observed effects among formulations or between isolates. Although estimated sorption-rate constants increased slightly with increased dissolved arsenate concentration, algae isolated from a site with elevated dissolved As had a significantly slower rate of As uptake compared with the same species isolated from an uncontaminated site upstream. Field and laboratory results indicate that the benthic flora represent a significant As pool, which may episodically affect water-column concentrations. (Author's abstract)
W90-08351

CONTRAST IN WINTER RAINWATER COMPOSITION: MARITIME VERSUS CONTINENTAL RAIN IN EASTERN NORTH CAROLINA.
North Carolina Univ. at Wilmington.
J. D. Willey, and R. H. Kiefer.
Monthly Weather Review MWREAB, Vol. 118, No. 2, p 488-494, February 1990. 2 fig, 4 tab, 29 ref. NSF Grants ATM-8512537 and ATM-8813353.

Descriptors: *Acid rain, *Chemistry of precipitation, *Convective precipitation, *Marine climates, *Meteorological data, *North Carolina, *Path of pollutants, *Water chemistry, Acid rain effects, Atmospheric pressure, Chemical composition, Conductivity, Industrial wastes, Ions, Nitric acid, Precipitation rate, Rainstorms, Saline water, Seasonal variation, Sulfuric acid, Water sampling, Weather patterns.

The two rain events that occurred in eastern North Carolina between January 25 and 27, 1986, illustrated the two major influences (continental versus

maritime) on winter rainwater composition received in this coastal region during the three winter quarters 1986-1989. Maritime rainwater from coastal storms like that of January 25-26, 1986, was similar to rain received in areas of the world remote from industrial activities. Rainwater from continental low pressure systems or cold fronts, like the cold front that brought rain on January 26-27, 1986, was much more acidic. These two influences caused great variation in rainwater composition over short periods of time. In maritime rainwater, the conductivity resulted primarily from seasalt; in continental rain, most of the conductivity came from sulfuric and nitric acids. Sequential sampling of these two types of storms indicated that the initial rain was the most acidic relative to subsequent rain in the same storm. Precipitation rate did not correlate with the concentration of any of the major ionic components in sequential samples from either type of storm. (Author's abstract)
W90-08368

MASS TRANSFER MECHANISM IN A POROUS RIVERBED.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
For primary bibliographic entry see Field 2E.
W90-08382

SOME FURTHER STUDIES ON FACTORS AFFECTING THE LEACHING OF LEAD FROM UNPLASTICIZED POLY (VINYL CHLORIDE) PIPES.
National Univ. of Singapore. Dept. of Chemistry.
M. K. Wong, L. M. Gan, L. L. Koh, and O. L. Lum.
Water Research WATRAG, Vol. 24, No. 4, p 451-455, April 1990. 9 fig, 3 tab, 8 ref.

Descriptors: *Drinking water, *Leaching, *Lead, *Pipes, *Potable water, *Water pollution sources, Chemical analysis, Extraction, Temperature effects, Water conveyance, Water distribution.

Several extractants were used to study the leaching rate of lead from unplasticized poly (vinyl chloride) pipes under different temperatures. The effects of the concentration of extractant and extraction time on the leaching of lead were also investigated. The results show that the complexing agent (EDTA) extracts much more lead from the pipes than other extractants. The study also shows that the extrusion temperature of the pipe affects the leaching rate of lead by tap water, nitrate, sulphate, carbonate, phosphate and EDTA. A lower rate of lead extraction is obtained from the pipe when extruded at 190 C compared to those extruded at 170 to 180 C. For a new unplasticized poly vinyl chloride (UPVC) pipe, the concentration of lead extracted by tap water or other extractants was much higher than the permissible level set by various national and international authorities. But the lead concentration decreased substantially to the acceptable level 10-15 extractions (at 2 day intervals) under static conditions at 27 C. The level of extracted lead is expected to be much lower if the pipe is used under dynamic conditions. (Chonka-PTT)
W90-08387

MICROBES, SEDIMENTS, AND ACIDIFIED WATER: THE IMPORTANCE OF BIOLOGICAL BUFFERING.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
A. L. Mills, P. E. Bell, and A. T. Herlihy.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 1-19, 4 fig, 2 tab, 63 ref.

Descriptors: *Acid rain effects, *Acidic water, *Biochemistry, *Microorganisms, *Path of pollutants, *Sediments, Alkalinity, Amino acids, Chemical reactions, Chemical reduction, Fermentation, Hydrogen ion concentration, Iron, Manganese, Neutralization, Nitrates, Photosynthesis, Sulfates.

Microorganisms in all environments play critical roles in the cycling of elements and mineralizing of organic matter. That role is not abandoned in

acidified environments, although different organisms may be involved and many of the processes may be lessened in terms of reaction rates. An additional role of microorganisms in acidic habitats is the generation of alkalinity by reduction of several of the components of the pollution itself, through photosynthesis, nitrate reduction, manganese and iron reduction, amino acid fermentation, methanogenesis, and sulfate reduction. A complete understanding of these homeostatic neutralization processes has not been reached, especially in terms of general concepts that can be applied to all systems, whether weakly or strongly acidified. Reactions other than sulfate reduction are not well studied, and their contribution to neutralization and alkalinity generation needs further work. The quantitative role of additional elements (such as iron) in the enhancement of the transport or reducible materials to the sediment and the contribution to alkalinity generation by its own reduction is unknown, but may be very important in all but the most dilute lakes. The entire area of microbial contribution to the biogeochemistry of acid environments is still fertile ground for research, and should continue to provide a wealth of new information for several years to come. (See also W90-08414) (Lantz-PTT)
W90-08415

SULFUR BIOGEOCHEMISTRY OF AN ACIDIC LAKE IN THE ADIRONDACK REGION OF NEW YORK.
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse. Dept. of Environmental and Forest Biology.
J. S. Owen, and M. J. Mitchell.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 59-68, 4 fig, 2 tab, 50 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Adirondack Mountains, *Biochemistry, *Path of pollutants, *Sediment-water interfaces, *Sulfur, Alkalinity, Chemical reactions, Geochemistry, Hydrogen ion concentration, Interstitial water, Lake sediments, New York, Sulfates.

Understanding biogeochemical cycling of sulfur (S) in limnetic systems necessitates quantifying the dynamics of inorganic and organic sulfur chemical species in water, seston, and sediment. For soils within a watershed, sulfate has a major role in regulating the removal of nutrient cations and alkalinity due to its association with the hydronium ion and its importance as a counter-ion. These watershed processes contribute to the chemistry of surface waters by regulating S transport from the watershed to lake systems. New information on pore water chemistry and sediment S speciation from acidic South Lake, NY is combined with previous data on the S biogeochemistry of this system. The total S profile found was similar to the S profile in South Lake sediment. A decrease in total S concentration with sediment depth below a subsurface maximum has been shown for several Adirondack lakes. Acid-volatile S represented < 10% of total S throughout the sediment profile and varied little with depth. Elemental S was also a minor constituent, representing < 5% of total S. The fraction of total S as residual sulfur varied but generally increased with sediment depth to 70% at 30 cm. Hydriodi acid-reducible S (ester sulfate) was > 40% of total S in surficial (0 to 4 cm) sediment and decreased below this depth to about 25% of total sulfur. There are a variety of mechanisms for S retention in lake sediments. An increase in limnetic sulfate concentrations will increase the rate of dissimilatory sulfate reduction in anaerobic water or sediments. Assimilatory sulfate incorporation (ester sulfate formation) or assimilatory sulfate reduction (carbon-bonded S formation) can also generate alkalinity. Formation of carbon-bonded S during sediment diagenesis might be inferred from the increase in the residual S fraction with depth. The annual H(+) flux in South Lake sediment was 5.7 mmol H/sq m/yr. The flux of H(+) between sediment and overlying water is a function of alkalinity generating processes such as dissimilatory sulfate reduction and denitrification. The estimated SO4(2-) flux to South Lake sediment was 10.0 mmol/sq m/yr, indicating that microbially

mediated processes in South Lake are less important than for some freshwater lake sediments. (See also W90-08414) (Lantz-PTT)
W90-08419

PHOSPHATE UTILIZATION BY BACTERIAL CULTURES AND ENRICHMENTS FROM ENVIRONMENTAL SAMPLES.
Ghent Rijksuniversiteit (Belgium). Lab. for Microbial Ecology.
D. Schowanek, and W. Verstraete.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 4, p 895-903, April 1990. 1 fig, 7 tab, 41 ref.

Descriptors: *Bacterial physiology, *Biodegradation, *Fate of pollutants, *Microbial degradation, *Path of pollutants, *Phosphorus compounds, Bacteria, Biochemistry, Degradation, Detergents, Phosphonates.

A selection of axenic microbial strains and a variety of environmental samples were investigated with respect to the utilization of a series of natural and xenobiotic phosphonates as the sole phosphorus source for growth. Phosphonate degradation was observed only with bacteria and not with eucaryotic microorganisms. All representatives of the phosphonates examined supported bacterial growth, with the exception of methylphosphonate diethylester. Yet, distinctly different phosphonate utilization patterns were noted between phosphonate-positive strains. C-P bond cleavage by a photosynthetic bacterium is reported for the first time; growing photoheterotrophically, Rhodobacteria capsulatus ATCC 23782 was able to utilize 2-aminoethylphosphonate and alkylphosphonates. Bacteria with the potential to utilize at last one of the phosphonate moieties from the xenobiotic phosphonates Dequest 2010, Dequest 2041, and Dequest 2060 were detected in all environments, with only two exceptions for Dequest 2010. Phosphonate P utilization to an extent of 94 and 97% for Dequest 2010 and Dequest 2041, provided evidence that a complete breakdown of these compounds with respect to the C-P bond cleavage can be achieved by some bacteria. The results suggest that phosphonate-utilizing bacteria are ubiquitous and that selected strains can degrade phosphonates that are more complex than those described previously. (Author's abstract)
W90-08424

INCIDENCE OF UREA-HYDROLYZING VIBRIO PARAHAEMOLYTICUS IN WILLAPA BAY, WASHINGTON.
Food and Drug Administration, Bothell, WA. Seafood Products Research Center.
C. A. Kaysner, C. Abeyta, R. F. Stott, J. L. Lilja, and M. M. Wekell.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 4, p 904-907, April 1990. 1 fig, 3 tab, 29 ref.

Descriptors: *Coliforms, *Path of pollutants, *Pathogenic bacteria, *Vibrio, Bacterial analysis, Bays, Microbiological studies, Oysters, Sediment contamination, Washington, Water analysis, Willapa Bay.

A high incidence (71.5%) of Vibrio parahaemolyticus was found in samples of water, oysters, and sediment from a Washington State estuary which produces a significant amount of commercial product. Strains of V. parahaemolyticus capable of hydrolyzing urea comprised 58.4% of all V. parahaemolyticus isolates tested. Values for fecal coliforms were within certification criteria for commercial harvest and were not correlated with levels of V. parahaemolyticus. Although there was a variable density of V. parahaemolyticus in types of sediment (sand, silt), there was no indication of a need for growing area closures based on high summer levels of V. parahaemolyticus, since a low incidence of thermostabile direct hemolysin strains was present within the total V. parahaemolyticus population. (Sand-PTT)
W90-08425

SEQUENTIAL ANAEROBIC DEGRADATION OF 2,4-DICHLOROPHEND IN FRESHWATER SEDIMENTS.
Georgia Univ., Athens. Dept. of Microbiology.
X. Zhang, and J. Wiegel.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 4, p 1119-1127, April 1990. 8 fig, 2 tab, 36 ref. DOE Grant DE-FG09-86ER 13614.

Descriptors: *Biodegradation, *Biotransformation, *Chlorinated hydrocarbons, *Fate of pollutants, *Lake sediments, *Microbial degradation, *Phenols, Biochemistry, Chemical reactions, Degradation, Path of pollutants, Sediment contamination, Water temperature.

2,4-Dichlorophenol (2,4-DCP) was anaerobically degraded in freshwater lake sediments. From observed intermediates in incubated sediment samples, and from enrichment cultures, the following sequence of transformations was postulated. 2,4-DCP is dechlorinated to 4-chlorophenol (4-CP), 4-CP is dechlorinated to phenol, phenol is carboxylated to benzoate, and benzoate is degraded via acetate to methane and CO2; at least 5 different organisms are involved sequentially. The rate-limiting step was the transformation of 4-CP to phenol. Sediment-free enrichment cultures were obtained which catalyzed only the dechlorination of 2,4-DCP, the carboxylation of phenol, and the degradation of benzoate, respectively. Whereas the dechlorination of 2,4-DCP was not inhibited by hydrogen, the dechlorination of 4-CP and the transformation of phenol and benzoate were. Low concentrations of 4-CP inhibited phenol and benzoate degradation. Transformation rates and maximum concentrations allowing degradation were determined in both freshly collected sediments and in adapted samples: at 31 C, which was the optimal temperature for the dechlorination, the average adaptation time for 2,4-DCP, 4-CP, phenol and benzoate transformations were 7, 37, 11, and 2 days, respectively. The maximal observed transformation rates for these compounds in acclimated sediments were 300, 78, 2130, and 2080 micromoles/L/day, respectively. The highest concentrations which still allowed the transformation of the compound in acclimated sediments were 3.1 mM 2,4-DCP, 3.1 mM 4-CP, 13 mM phenol, and > 52 mM benzoate. The corresponding values were lower for sediment which had not been adapted for the transformation steps. (Author's abstract)
W90-08428

PATTERN OF SOLUTE MOVEMENT FROM SNOW INTO AN UPPER MICHIGAN STREAM.
Michigan Technological Univ., Houghton. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2A.
W90-08434

MERCURY POLLUTION DUE TO GOLD MINING IN THE MADEIRA RIVER BASIN, BRAZIL.
O. Malm, W. C. Pfeiffer, C. M. M. Souza, and R. Reuther.
AMBIO AMBOCX, Vol. 19, No. 1, p 11-15, 1989. 2 fig, 4 tab, 25 ref.

Descriptors: *Brazil, *Mine wastes, *Path of pollutants, *Water pollution sources, Bioaccumulation, Ecosystems, Gold mining, Heavy metals, Madeira River, Public health, Sediment contamination, Soil contamination.

Since the late 1970s, many rivers and waterways in the Amazon have been exploited for gold mining. Mercury (Hg) is used in the mining process as an amalgamate to separate the fine gold particles from the other mineral components in the bottom gravel. During this process, part of the mercury (5-30%) is lost or discharged directly into the river. In the final recovery of the gold, considerable amounts of the mercury (about 20%) are released to the atmosphere. In 1986, three research groups came together to study the environmental impact caused by the use of mercury in the Madeira River system. Four main sampling surveys were carried out in this area, from October 1986 until June 1988.

Concentration ranges determined for total mercury in water, suspended and bottom sediments, and soil collected along the Madeira River and in smaller forest streams show that 80% are within the range of the natural background found for Hg in the literature (i.e. 0.1 microgram/g and 0.19 microgram/g). Extremely high concentrations of mercury were observed in air samples close to reburning facilities (292 microgram/cubic meter). The high mercury values (up to 40.0 and 31.8 micrograms/g) found in hair of both Indians and gold miners, from the region indicate that the uptake of mercury by man from fish has already reached a stage at which severe health effects due to acute Hg poisoning can be expected. The results suggest that the release of Hg during gold mining represents a direct environmental threat for local ecosystems and people in this part of the Amazon. (Agostine-PTT)
W90-08444

DISCHARGE OF NUTRIENTS FROM SWEDISH FISH FARMING TO ADJACENT SEA AREAS.
Stockholm Univ. (Sweden). Dept. of Zoology.
H. Ackefors, and M. Enell.
AMBIO AMBOCX, Vol. 19, No. 1, p 28-35, 1989. 5 fig, 7 tab, 25 ref.

Descriptors: *Aquaculture, *Fish farming, *Nutrient loads, *Water pollution sources, Mathematical equations, Nitrogen, Path of pollutants, Phosphorus, Sweden.

Local environmental county authorities, responsible for licensing fish farming, have to calculate the total input of nutrients from the farming activity and compare these amounts with the existing loads and input sources, as well as calculating the anticipated effect of an increased load. For this reason, it is necessary to have a simple and accurate equation that can be used for calculating the phosphorus and nitrogen loads of cage-fish-farming activities.This paper deals with phosphorus and nitrogen loads resulting from Swedish fish-farming operations. Since the phosphorus and nitrogen load from a cage-fish farm depends on the feed coefficient and the phosphorus and nitrogen content of the feed used, the nutrient loads for different farms can vary greatly. The equations given use the weight of feed pellets as well as the percentages of nitrogen and phosphorus in the feed to calculate phosphorus and nitrogen loads from fish farming. From the actual 1986 fish production of 3945 tons, from the licensed production of 17,323 tons, and from a scenario of 40,000 tons, the load of phosphorus was calculated to be about 35 tons and the load of nitrogen was 260 tons. These loads correspond to 0.6% and 0.2% of the total Swedish phosphorus and nitrogen load on the surrounding sea areas. Compared to the total load from all surrounding countries, including atmospheric deposition, the share of the Swedish fish-farming activities to the adjacent seas is 0.05% for phosphorus and 0.02% for nitrogen. The contribution of phosphorus and nitrogen via precipitation and dry deposition over the Swedish land area is about 100 times greater for phosphorus and 1100 times greater for nitrogen, than the load from all Swedish fish-farming operations. It is concluded that the overall nutrient load from aquaculture is negligible in comparison with other nutrient sources. (Agostine-PTT)
W90-08447

IDENTITY OF CHLORINATED ORGANIC SUBSTANCES IN AQUATIC ORGANISMS AND SEDIMENTS.
Lund Univ. (Sweden). Dept. of Technical Analytical Chemistry.
C. Wesen, G. E. Carlberg, and K. Martinsen.
AMBIO AMBOCX, Vol. 19, No. 1, p 36-38, 1989. 1 tab, 27 ref.

Descriptors: *Chlorinated hydrocarbons, *Path of pollutants, *Pollutant identification, *Water pollution sources, Bioaccumulation, Chemical analysis, Cod, Fate of pollutants, Fish, Hydrolysis, Sediment contamination, Sweden, Tissue analysis.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B—Sources Of Pollution

Many chlorinated organic pollutants in the aquatic environment are persistent and bioaccumulate. They can be found in sediment and organisms, both in waters receiving industrial discharges and from remote locations. By measuring the chlorine concentration of an extract with neutron activation analysis (NAA), the extractable, organically bound chlorine (EOCl) can be determined, thus assessing the chlorine associated with all substances extractable with a nonpolar solvent. The chlorine bound to identified pollutants normally contributes to < 10-15% of the EOCl in fish and about 5% in sediments. Recent findings indicate that some of the unidentified EOCl is in the form of compounds with molecular weights similar to those of lipids. The objective of this study was, therefore to hydrolyze EOCl from fish and sediment samples and to characterize the hydrolysis products. Before hydrolysis, the EOCl compounds are neutral. Between 60 and 80% of EOCl was hydrolyzed by lipase, and 30% of cod liver EOCl was recovered as acidic material. The findings showed that a considerable portion of the unidentified, chlorinated substances is bound in esters, thought to be chlorinated phenolic compounds or chlorinated carboxylic acids. (Agostine-PTT)
W90-08448

ARSENIC IN AQUATIC ORGANISMS: A REVIEW, EMPHASIZING CHEMICAL SPECIATION.
Aquatic Habitat Inst., Richmond, CA.
D. J. H. Phillips.
Aquatic Toxicology AQTODG, Vol. 16, No. 3, p 151-186, April 1990. 4 fig, 5 tab, 195 ref.

Descriptors: , *Arsenic, *Arsenic compounds, *Bioaccumulation, *Literature review, *Path of pollutants, Animal physiology, Aquatic animals, Crustaceans, Ecosystems, Mollusks, Plankton, Public health.

Much of the present total world production of arsenic, about 30,000 tons annually, is intentionally released into the environment, from both industrial and agricultural sources. The aquatic environment is important in the global cycling of arsenic, and arsenic concentrations in the biota of aquatic ecosystems are much higher than those found in organisms inhabiting terrestrial environments. Permissible dissolved total or 'recoverable' concentrations of arsenic vary between 8 and 500 microgram per liter, according to several authorities including the Environmental Protection Agency. In its inorganic forms arsenic has significant toxicity to both aquatic biota and mammals, including humans. The precise chemical species of arsenic present in aquatic environments and in the food and drink of humans are now known to be the most important factors defining the accumulation of the element by biota and its toxicological impacts. In many cases, the concentrations of the element accumulated appear to be more heavily dependent on the species concerned, rather than the degree of contamination of the ambient environment by arsenate. This is true of plankton, macroalgae, molluscs, crustaceans, polychaetes, and teleosts. Age is also a factor in the variation of arsenic accumulation within a species. For anabolic pathways, it is well established that arsenate is taken up, reduced and methylated by primary producers, probably as a detoxification mechanism. Catabolic pathways appear to be involved in the decompositions of arseno-sugars and arsenobetaines. Both of these are probably bacterially-mediated processes. In humans, data has shown that arsenic from seafood is efficiently absorbed, and most of the ingested arsenic is subsequently excreted over a short period by humans and other mammals. The identity of the arsenic compounds which are not rapidly excreted by humans and their toxicological importance, are unknown at present. It therefore remains possible that arsenic in aquatic species represents a long-term toxicological hazard. (Agostine-PTT)
W90-08450

BIOTRANSFORMATION AND OTHER TOXICOLOGICAL AND PHYSIOLOGICAL RESPONSES IN RAINBOW TROUT (SALMO GAIRDNERI RICHARDSON) CAGED IN A LAKE RECEIVING EFFLUENTS OF PULP AND PAPER INDUSTRY.

Kuopio Univ. (Finland). Dept. of Physiology.
P. Lindstrom-Seppa, and A. Oikari.
Aquatic Toxicology AQTODG, Vol. 16, No. 3, p 187-204, April 1990. 2 fig, 5 tab, 48 ref.

Descriptors: *Bioaccumulation, *Biotransformation, *Fate of pollutants, *Industrial wastewater, *Path of pollutants, *Pulp and paper industry, *Pulp wastes, *Trout, *Water pollution effects, Chlorinated hydrocarbons, Effluents, Enzymes, Finland, Fish physiology, Lake Saimaa, Phenols.

Hatchery reared immature rainbow trout (Salmo gairdneri Richardson) were transferred to eight field stations at the southern Lake Saimaa (SE Finland). They were caged in the receiving water body of effluents from a mill producing chlorine bleached kraft pulp and printing paper. The controls were caged upstream to the sewer. The microsomal cytochrome P-450 content, NADPH cytochrome c reductase and monooxygenase enzyme activities as well as conjugation reactions with glucuronic acid and glutathione were studied in the liver, kidney, and gills. Conjugated metabolites of chlorophenolics in the bile and some physiological blood parameters were investigated. While cytochrome P-450 and NADPH cytochrome c reductase were unresponsive, clear monooxygenase induction was seen. The induction was closest downstream to the pulp mill, and the response decreased toward more distant locations. Compared to control trout, up to 7 times induction of liver 7-ethoxyresorufin O-deethylase (EROD) activity was observed at the nearest station, 3 km from the effluent outlet. Activity of EROD was the best indicator for the induction caused by pulp and paper mill effluent, however, pentoxyresorufin O-dealkylase was also responsive. Analysis of conjugated chlorinated phenolics in the bile showed the highest concentrations at the caging station nearest to the mill and displayed good distance related decreases. The levels of conjugated toxicants found in fish indicated a low contamination of the whole southern Lake Saimaa. There is still no evidence as to which particular constituents cause effects on the polysubstrate monooxygenase system in fish. The biotransformation responses can, despite this fact, function well as early warning biomarkers of the effluents of pulp and paper mills. (Agostine-PTT)
W90-08451

INDICES OF TRIAZINE TOXICITY IN CHLAMYDOMONAS GEITLERI ETTL.
Manitoba Univ., Winnipeg. Dept. of Botany.
For primary bibliographic entry see Field 5C.
W90-08452

CHEMICAL POLLUTION STATUS OF THE NORTH SEA.
Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab.
J. E. Portman.
Dana DANADZ, Vol. 8, No. 1989, p 95-108, 1989. 11 fig, 4 tab.

Descriptors: *North Sea, *Path of pollutants, *Water pollution, *Water quality, Estuaries, Heavy metals, Reviews.

Of the many seas in the world the North Sea ranks high in several respects: the number of different countries that can potentially affect its quality and the range of activities and fisheries it supports being but two. There is considerable public and official interest in the quality and status of this important sector of the marine environment and the influence man's activities may be having on it. This paper reviews what is known and understood about the chemical quality of the North Sea and examine the extent to which this information supports some of the claims that the North Sea is heavily polluted and in serious danger of irreversible damage. The paper also assessed the present trends, and those likely to occur in the future, of both inputs of chemical contaminants and their effects. This section pays particular attention to what is known and what is desirable should be known and how this might be achieved. The bulk of the material used for developing the paper was drawn from that available to the author through

involvement in ICES and GESAMP activities including the concentration of heavy metals, gamma-BHC, nitrogen and phosphate. Quantitation data are given for sources and distribution in fish and shellfish. (Author's abstract)
W90-08455

SIGNIFICANCE AND TREATMENT OF VOLATILE ORGANIC COMPOUNDS IN WATER SUPPLIES.
For primary bibliographic entry see Field 5F.
W90-08509

MANAGEMENT CONTROLS OF VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER PROTECTION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 5G.
W90-08511

TRANSPORT, DISTRIBUTION, AND FATE OF VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
R. W. Gillham, and P. S. C. Rao.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 141-181, 12 fig, 2 tab, 93 ref.

Descriptors: *Fate of pollutants, *Groundwater pollution, *Path of pollutants, *Volatile organic compounds, *Water pollution sources, Advection, Biodegradation, Case studies, Dispersion, Geochemistry, Gravel, Groundwater movement, Hydrolysis, Oil spills, Petroleum products, Sand, Solute transport, Sorption.

With large proportions of domestic water supplies originating as groundwater (> 50% in the United States, almost 30% in Canada, and about 70% in Europe), the manner in which organic contaminants enter, migrate, and dissipate in groundwater flow systems is an important issue in water supply. In a large number of cases organic contaminants are introduced as an immiscible phase; attempts to characterize their behavior in geohydrologic settings challenge both intuitive and mathematical capabilities. Though volatile organic contaminants (VOCs) may enter the subsurface as an immiscible phase, in the majority of cases they reach environmentally sensitive areas (such as wells or groundwater discharge zones) as dissolved constituents of the aqueous phase. Considering only saturated geologic materials, advection and dispersion are generally considered to be the principal physical transport processes, though the possible role of colloid transport and filtering effects on colloids are beginning to be assessed. Considering only VOCs, the chemical and biochemical processes of greatest relevance include sorption, oxidation, hydrolysis, and biodegradation. The processes invariably interact in some manner, and the problem of prediction is further complicated because the expression of the processes is frequently determined by the nature of the geologic material. Contaminant transport in sand and gravel is given primary attention because those geologic materials are common sources of groundwater supply. While there are innumerable examples of VOC transport in groundwater, the majority are associated with actual leaks and spills. In these situations, there is generally poor definition of the volume of the non-aqueous-phase liquids released and the spatial and temporal characteristics of the release. In addition, there is seldom sufficient monitoring for a detailed analysis of the transport processes and the manner in which the processes interact. An overview of two experiments involving the controlled release of dissolved organic contaminants to a sand aquifer is given. (See also W90-08509) (Lantz-PTT)
W90-08518

PHYSICAL-CHEMICAL PROPERTIES AND FATE OF VOLATILE ORGANIC COM-

POUNDS: AN APPLICATION OF THE FUGACITY APPROACH.
Toronto Univ. (Ontario). Inst. for Environmental Studies.
D. Mackay, and W. Y. Shiu.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 183-204, 7 fig, 4 tab, 44 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Physicochemical properties, *Volatile organic compounds, Air-water interfaces, Bioassay, Chemical analysis, Chemical properties, Organic compounds, Physical properties, Pollutant identification.

Owing to industrial and domestic emissions, spills, leaching from disposal sites and deliberate or inadvertent transformation reactions, surface and groundwater supplies are frequently contaminated with volatile organic compounds (VOCs). The physical/chemical properties of this set of compounds and the influence of these properties upon their behavior are described. The properties considered are: molecular weight, chemical formula, melting point, boiling point, water solubility, vapor pressure, octanol-water partition coefficient, solubility in octanol, Henry's Law constant, and air-water partition coefficient. These properties influence how the VOCs are detected and analyzed, how they migrate in and from water, and how they can be removed. Ultimately, these characteristics influence how organisms, especially humans, become exposed to VOCs. The physical-chemical properties of selected VOCs are reviewed and their common characteristics identified. The use of these properties to describe or predict equilibrium partitioning tendencies using the fugacity approach is discussed. Applications of this approach are illustrated for bioassays, indoor exposure, and groundwater. By assuming typical volumes for air, water and fish under bioassay conditions, it is possible to calculate how a VOC will partition among them. By applying this approach to water containing chloroform drawn in a bathroom, it is shown that under certain conditions, exposure to chloroform by breathing would exceed exposure caused by drinking 2 L water/day. The examples indicate that the primary inter-media transfer process of concern for VOCs is from the water to the atmosphere but similar calculations can be made for partitioning from water to fish or sediments. (See also W90-08509) (Lantz-PTT)
W90-08519

BIOLOGICAL TRANSFORMATIONS OF VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER.
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
F. K. Pfaender.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 205-226, 4 tab, 93 ref.

Descriptors: *Biodegradation, *Biotransformation, *Fate of pollutants, *Groundwater pollution, *Path of pollutants, *Volatile organic compounds, Aerobic conditions, Anaerobic conditions, Aquifers, Biochemistry, Chemical reactions, Microbial degradation, Mineralization, Organic compounds.

The microbial world is populated with organisms capable of transforming volatile organic compounds under a variety of conditions. Aerobic and anaerobic biodegradation have been shown to occur and some products have been identified. Under both sets of conditions the mineralization of VOCs has been shown to be possible. The present challenge is to use this information to produce efficient and cost-effective remediation tools--a task that may prove to be difficult. The abiotic and mammalian reactions with VOCs have been addressed in several reviews of VOC transformations, and fall into four general categories of potential transformations: (1) oxidation reactions; (2) reduction reactions; (3) substitution reactions; and (4) dehydrohalogenation reactions. In the early 1980s, several studies suggested that VOCs were not bio-

logically degraded under a variety of aerobic conditions. More recently, several different types of aerobic microorganisms have been shown to possess enzymes capable of transforming VOCs. These include the methanotrophic bacteria and several groups of aerobic heterotrophic bacteria. The anaerobic biodegradation of VOCs has been the focus of several investigations, some of which involve samples from the subsurface or simulated groundwater environments. These studies have examined: (1) anaerobic biodegradation of PCE and TCE; (2) anaerobic degradation of other halogenated two carbon compounds; and (3) anaerobic metabolism of one-carbon compounds. (See also W90-08509) (Lantz-PTT)
W90-08520

TOTAL EXPOSURE TO VOLATILE ORGANIC COMPOUNDS IN POTABLE WATER.
Pittsburgh Univ., PA. Dept. of Industrial Environmental Health Sciences.
For primary bibliographic entry see Field 5F.
W90-08529

IMPORTANCE OF CLIMATOLOGICAL VARIABILITY AND THE RATE AT WHICH WASTE IS ADDED TO MODELING WATER BUDGET OF LANDFILLS.
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 5E.
W90-08562

WATER RESOURCES OF THE DANUBE RIVER BASIN; SOURCES OF POLLUTION AND CONTROL AND PROTECTION MEASURES.
Novi Sad Univ. (Yugoslavia). Faculty of Technical Sciences.
M. Miloradov.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 1-12, 1990. 7 fig, 7 tab, 8 ref.

Descriptors: *Danube River, *Water pollution control, *Water pollution sources, *Water quality management, Monitoring, Water quality, Water quality standards.

The water balance of the Danube River basin has been studied by many authors and research institutions. Recently, the most complete analyses have been made by the relevant institutions of the eight Danubian countries which, in the period of 1976 to 1986, produced a Hydrological Monograph of the Danube basin consisting of three parts: (a) physical and geographical characteristics; (b) hydrological regime; and (c) water balance. This paper discusses the results reported in the Monograph. Currently, water quality is monitored at 520 stations by 6 to 12 series of measurements. The systematic examinations include: (1) hydrological indicators such as water level, discharge, velocity, and water temperature; (2) meteorological indicators such as air temperature, precipitation, and cloudiness; (3) visual and olfactory indicators; (4) saprobiological measurements such as degree of saprobity and saprobic index; (5) bacteriological measurements; and (6) physico-chemical indicators such as pH, electrical conductivity, suspended solids, and biochemical oxygen demand. The results of the systematic examinations indicate certain generalities which can be concluded related to the low discharge capacities of watercourses, size of catchments, and the influence of major point sources of pollution. The results of these experiments also show that very often, values of certain parameters do not meet the required quality standards. There is a continuous trend of deterioration in the water quality of the watercourses, including the Danube. It is well known that the main sources of pollution are municipal and industrial sewage and wastewaters, thermo-electric and nuclear power plants, agriculture, and many non-point sources, such as pollution arising from precipitation. The control and protection measures can be classified into two groups: (a) management of the water regime, including an increase in the minimum discharges and increased dilution of highly polluted waters; and (b) changes in technological processes aimed at reducing wastewater volumes and imple-

menting wastewater treatment processes. The results clearly indicate the need for better cooperation between the Danubian countries, and for much more action to be taken regarding all aspects of protection so that no further pollution or degradation of the Danube and its tributaries occurs. (Agostine-PTT)
W90-08605

CHANGES IN THE COMPOSITION OF THE DANUBE RIVER BASIN BIOCENOSIS RESULTING FROM ANTHROPOGENIC INFLUENCES.
Novi Sad Univ. (Yugoslavia). Inst. of Biology.
For primary bibliographic entry see Field 5C.
W90-08606

ESTIMATION OF THE READILY OXIDIZABLE ORGANIC MATTER RESERVE AND ITS EFFECT ON THE INTENSITY OF ORGANIC MATTER DESTRUCTION BY BACTERIA IN THE DANUBE RIVER.
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 2H.
W90-08607

ECOTOXICOLOGICAL STUDIES ON THE KILIAN BRANCH AND DELTA OF THE RIVER DANUBE.
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
L. P. Braginsky, F. Y. Komarovsky, P. N. Linnik, O. V. Maslova, and E. P. Shcherban.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 35-38, 1990. 1 tab, 2 ref.

Descriptors: *Chemical analysis, *Ecotoxicology, *Path of pollutants, *Pollutant identification, *Toxicology, *Water pollution effects, Atomic absorption spectrophotometry, Chlorinated hydrocarbons, Colorimetry, Fish, Gas chromatography, Heavy metals, Pesticides, Plankton, Sediment contamination, Tissue analysis, Toxicity.

Amounts of priority toxicants (heavy metals, petroleum and petroleum products, surfactants, phenols, organochorine pesticides) in water, bottom sediments, macroinvertebrates, fish, and birds of the Kilian branch and delta of the River Danube were studied from 1978 to 1985. The basic methods used to determine the levels of the inorganic pollutants were atomic adsorption spectrophotometry, and kinetic and luminescent methods. Colorimetry and gas chromatography were used for the organic pollutants. Organochlorine pesticides were extracted from the tissues of aquatic organisms by n-hexane. The bottom sediments and larger organisms were shown to be highly polluted by pesticide residues and heavy metals. In the water, organochlorine pesticides were almost completely adsorbed on suspended particles, while metals were found both in solution and in the suspended phase, forming high molecular weight complex compounds. Accumulation coefficients for DDT in the higher links of trophic chains (i.e., predatory fish, fish-eating birds) were one hundred thousand to one million. Danube river water was found to have both acute and chronic toxicity, which was confirmed by biotesting on planktonic crustaceans. Toxicity varied in time and was of a pulsed character. (Author's abstract)
W90-08608

LONG TERM INVESTIGATION OF THE RIVER DANUBE WATER QUALITY IN THE YUGOSLAV SECTION ACCORDING TO MICROBIOLOGICAL PARAMETERS.
Novi Sad Univ. (Yugoslavia). Inst. of Biology.
For primary bibliographic entry see Field 5C.
W90-08609

STUDIES ON THE CONTAMINATION STATUS OF THE DANUBE RIVER BASIN WATERS, MEASURES OF PROTECTION, AND RATIONAL EXPLOITATION OF THE WATER RESOURCES.

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B—Sources Of Pollution

Institute for Biological Research, Belgrade (Yugoslavia). Dept. of Ichthyology.
D. V. Jankovic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 45-50, 1990. 1 fig, 15 ref.

Descriptors: *Danube River, *Laboratory methods, *Path of pollutants, *Sediment contamination, Aquatic environment, Metals, Seasonal variation, Spectrometry, Water quality, Yugoslavia.

The water quality of the surface and groundwaters, and the characteristics of the aquatic organism communities of the Yugoslav stretch of the River Danube were investigated. Every year, beginning in 1985, investigations were conducted during May, at high water periods, and in September, at average low water periods. Using simultaneous sampling, the following were carried out: analysis of the quality of wastewaters emitted by the largest polluters; estimation of mass flow and transfer; geochemical and hydrochemical research; microbiological research; limnological research; analysis of the concentration of pollutants in the aquatic communities; analysis of water management and fishery problems; and, investigation of measures of protection and rational exploitation of the Yugoslav stretch of the Danube River. River flow rates were estimated according to recorded water levels and the hydrodynamic and morphological characteristics of certain profiles, and by using a mathematical model which included operation of the Djerdap Hydroelectric Power Station. During May 1986, flow rates were 3200 to 6000 cu m/sec, and in September they were twice as slow. For the 14 metals analyzed, the water samples were satisfactory, while the content of the metals in the pelitic fraction (i.e., diameter < or = 2 micrometers) of the sediments indicated the existence of pollution. The pelitic fraction of the sediments was subjected to trace element analysis by an emission spectrographic technique using germanium as an internal standard. The overall precision was +/-12%. Saprobiotic analysis of trace elements in the water, sediment, and aquatic communities indicated the transfer of pollutants between the various ecosystem compartments. (Agostine-PTT)
W90-08610

LONG-TERM AND SEASONAL ASPECTS OF THE WATER QUALITY OF THE RIVER DANUBE WITHIN THE REGION OF VIENNA (AUSTRIA).
Oesterreichisches Inst. fuer Wirtschaftsforschung, Vienna.
C. Ludwig, H. Ranner, G. Kavka, W. Kohl, and U. Humpesch.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 51-58, 1990. 5 fig, 3 tab, 6 ref.

Descriptors: *Danube River, *Path of pollutants, *Water pollution sources, Ammonia, Austria, Bacterial analysis, Biochemical oxygen demand, Hydroelectric plants, Orthophosphates, Potassium permanganate, Regression analysis, Water quality.

The water quality of the Austrian part of the River Danube has been studied over the last twenty years by the Federal Institute of Water Quality. Data on water quality variables from 1968 to 1987 are analyzed statistically. The long-term changes of five selected variables (ammonia, orthophosphate, biochemical oxygen demand in two days (BOD2), potassium permanganate demand, and colony counts of saprophytic bacteria (colony count)), are investigated at four different sampling sites, two upstream and two downstream from Vienna. Trends were studied using linear regression analysis. The regression lines for ammonia indicate increases at all sampling sites, especially on the right bank. The trends for orthophosphate are not unique and the correlation coefficients are very low. The values for the BOD2 generally increase during the investigation period. For potassium permanganate and colony count, a generally decreasing trend was exhibited. The building of six hydropower plant stations in the Austrian river section has changed such conditions as the water velocity and has led to increased sediment. Increasing water temperature, caused by the discharge of high amounts of cooling water and by the longer flow

time, is able to increase the probability of primary production. About two-thirds of the total nitrogen and one third of the total phosphorus originate from nonpoint sources. If any activities are planned to achieve a better water quality in the Austrian section of the Danube River, this aspect must be taken into consideration. (Agostine-PTT)
W90-08611

QUALITATIVE AND QUANTITATIVE ANALYSIS OF HEAVY METALS IN THE DANUBE AT THE PROFILE SITUATED AT THE VILLAGE OF VINCA, YUGOSLAVIA.
Water Supply and Sewage of Belgrade (Yugoslavia).
A. Marjanovic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 59-62, 1990. 1 tab, 6 ref.

Descriptors: *Danube River, *Heavy metals, *Path of pollutants, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, Pollutant identification, Vinca, Water chemistry, Yugoslavia, Zinc.

Qualitative analyses of water from the Danube River were conducted to determine the changes in the concentrations of heavy metals during the period 1985 to 1987. The samples were collected from a locality situated on the right bank of the river at the village of Vinca. The heavy metals Pb, Cd, Zn, Cu, Fe, Mn, As, Ni, and Hg were found to be constantly present in the river water, whereas the ions Cr(+3) and Cr(+4) were not detected. It was found that the tendency for levels of these heavy metals to increase had ceased. The number of samples containing major ecotoxic elements (Pb, Cd, and Hg) was reduced, and a slight improvement was also recorded with regard to the other heavy metals, with the exception of Zn. (Author's abstract)
W90-08612

PHOSPHATASE ACTIVITY OF WATER AS A MONITORING PARAMETER.
Novi Sad Univ. (Yugoslavia). Inst. of Biology.
For primary bibliographic entry see Field 5A.
W90-08613

IMPACT OF FURTHER IMPOUNDMENTS ON THE OXYGEN BALANCE AND WATER QUALITY OF THE DANUBE IN GERMANY.
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
For primary bibliographic entry see Field 6G.
W90-08614

CONTENT OF HEAVY METALS IN SOME FISH SPECIES IN THE SECTION OF THE DANUBE FLOWING THROUGH VOJVODINA.
Novi Sad Univ. (Yugoslavia). Inst. of Biology.
V. Pujin, N. Djukic, S. Maletin, S. Obradovic, and D. Kostic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 79-86, 1990. 4 fig, 1 tab, 10 ref.

Descriptors: *Bioaccumulation, *Danube River, *Heavy metals, *Path of pollutants, *Water pollution sources, Aluminum, Cadmium, Chromium, Cobalt, Comparison studies, Copper, Fate of pollutants, Fish, Gills, Iron, Lead, Manganese, Nickel, Seasonal variation, Strontium, Tissue analysis, Yugoslavia, Zinc.

The content of 11 heavy metals (Al, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Sr, Zn) was analyzed in certain tissues and organs in 12 fish species in the river Danube, Vojvodina (Yugoslavia). The material for the research was caught during the spring and autumn of 1988 in the Danube, between the 1225th and 1276th kilometer. The level of accumulation of certain metals in the organs and tissues of the investigated fish species in both seasons was similar and can be placed in the following order : Fe > Al > Zn > Cu > Mn > Sr > Pb > Cr > Ni > Cd > Co. In the spring sample, all fish species accumulated in their intestines the largest amounts of Al, followed by those of Fe, Zn, and Cu, while in the muscles, the order was: Zn, Fe,

Al, and Sr. The level of the other metals was negligible. The total accumulation of heavy metals in the organs and tissues of the fish studied shows that the heavy metals content is much higher in the intestines than in the muscles, except for in piscivores (E. lucius most of all). (Agostine-PTT)
W90-08615

SOME ASPECTS OF POLLUTION OF THE DANUBE.
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
O. G. Tarasova, A. M. Tsvetkova, L. F. Osipov, O. M. Arsan, and N. A. Klujev.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 93-97, 1990. 2 fig, 2 tab, 5 ref.

Descriptors: *Danube River, *Path of pollutants, Austria, Bioaccumulation, Bottom sediments, Chlorinated hydrocarbons, Fish, Oil pollution, Organic compounds, Organic pollutants, Pesticides, Pollutant identification, Polychlorinated biphenyls, Sediment contamination, USSR, Vienna.

During the first International Danube Research Expedition (March 1988), organochlorine pesticide residues in water, bottom sediments, and fish tissues were studied using chromatographic methods, infrared spectrometry and mass spectrometry. Several other organic pollutants were identified as well. The data presented concern the abiotic environment of the Danube from the estuary (USSR) to Vienna (Austria). The amount of suspended matter in Danube water was determined gravimetrically and the organic matter contents were estimated by the weight losses after calcination. Correlation of total oil content, suspended matter, and residues of hexachlorcyclohexane (HCH) isomers was not significant, and DDT and metabolites were not detected in Danube water. Toluene, ethylbenzene, indole, tetrachlorbiphenyl and the components of diesel oil were shown to be present in native (non-filtered) water (Vienna). Six tetrachlorbiphenyl isomers, four pentachlorbiphenyl isomers, two hexachlorbiphenyl isomers, and the polyaromatic compounds phenanthrene, chryzene, methylchryzene, pyrene, methylpyrene, benzopyrene, and diesel oil were also revealed in bottom sediments (Novi Sad). The presence of tetrachlorbiphenyls in the tissues of carpbeam fish (Gapchikovo, USSR), and pentachlorbiphenyls in the tissues of barbel fish (Vishegrad, Hungary) was detected as well. It is concluded that pollution of the abiotic environment of the Danube by several persistent organochlorine pesticides has decreased significantly and only sometimes reached the background levels of 1979-1980's. The quality of the abiotic environment could however be dramatically affected by polychlorinated biphenyls, oil and polyaromatic hydrocarbons. (Agostine-PTT)
W90-08617

WATER BIOLOGICAL SUFFICIENCY AND QUALITY OF THE BULGARIAN DANUBE STRETCH (845-375 RIVER KM).
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
For primary bibliographic entry see Field 5A.
W90-08618

RESIDUES OF PERSISTENT ORGANOCHLORINE COMPOUNDS IN SELECTED AQUATIC ECOSYSTEMS OF VOJVODINA (YUGOSLAVIA).
Novi Sad Univ. (Yugoslavia). Faculty of Science.
M. B. Vojinovic, S. T. Pavkov, and D. D. Buzarov.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 107-111, 1990. 3 tab, 10 ref.

Descriptors: *Chlorinated hydrocarbons, *Danube River, *Path of pollutants, *Tisza River, *Water pollution sources, Bioaccumulation, DDT, Fate of pollutants, Gas chromatography, Insecticides, Lake Palic, Monitoring, Pesticides, Pollutant identification, Polychlorinated biphenyls, Sediment contamination, Water birds.

The concentration of a wide range of persistent organochlorine compounds, alpha-, beta-, and gamma-hexachlorocyclohexane(HCHs), p,p'dichloro-diphenylethane (DDE), o,p'DDE, p,p'dichloro-diphenyl-trichloroethane (DDT) and polychlorinated biphenyls (PCBs) in the aquatic environment of the: Danube River, Tisza River, Lake Palic, and fish-pond Ecka, are reported. The residues of organochlorine insecticides (OCI) and PCBs in water, sediments, fish muscle and eggs of aquatic birds were analyzed. OCI residues were determined by gas chromatography, while PCB congeners were quantified by high-resolution gas chromatography. In all examined specimens persistent residues of OCI and PCBs were found. The total HCH, total DDT and PCB congeners were present in high concentrations in all examined samples. Because of the concentration of these compounds at top levels, fish, eggs of aquatic birds and sediments are an excellent indicator for detecting trace organic compounds whose presence in water would be difficult to measure directly. It should be noted that atmospheric transport of toxic organochlorine compounds and PCBs from source regions and subsequent deposition to receptors (water) is the most important pathway for distributing anthropogenic organic compounds globally. (Author's abstract)
W90-08619

WATER QUALITY OF THE DANUBE IN HUNGARY AND ITS MAJOR DETERMINING FACTORS.
Eszak-Dunantuli Kornyezetvedelmi es Vizugyi Igazgatosag, Gyor (Hungary).
P. Varga, M. Abraham, and J. Simor.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 113-118, 1990. 1 fig, 1 tab, 7 ref.

Descriptors: *Danube River, *Water pollution sources, *Water quality, *Water quality management, Eutrophication, Flooding, Nitrates, Organic loading, Phosphates, Pollution load, Seasonal variation.

Three District Water Authorities cover the whole Hungarian stretch of the Danube River. Since the formation of the monitoring network fifteen years ago, the water quality has been observed at fifteen sampling points. Throughout this time, sampling has been performed under different hydrometeorological conditions. Based on these investigations, it was found that the quality of the river was influenced equally by local and hydrometeorological conditions. Major pollution sources are: the sewage from Bratislava, Gyor and Budapest; the paper, pulp, chemical, and sugar beet factories in the Slovakian catchment; the Hungarian chemical, petro-chemical, and food industries; and nonpoint source pollution from agriculture. The effects of these sources depend on the degree of wastewater treatment, and on the mixing rate. The waste loads provide a continuous source of nutrients, giving rise to bacterial proliferation. The organic nitrate and phosphorus loads are increasing, which is compensated for by biodegradation. In the winter, when the water temperature falls below 10 C and solar radiation is low, saprobic conditions characterize the water quality. In the summer, when solar radiation and temperature increase, trophic conditions determine the water quality. Thus, in winter the ammonia content increases, but in the spring, nitrification starts to improve and, especially in the lower reaches, algal over-production can be detected. This situation changes during flood periods, when the concentration of polluting material is decreased by dilution, and at the same time, the high level of suspended solids inhibits the growth of organisms needing solar radiation. The most unfavorable water quality conditions occur in the winter low-flow period, when problems may occur in drinking water supply if the water is chlorinated. (Author's abstract)
W90-08620

HEAVY METAL CONTENTS IN INVERTEBRATES OF THE DANUBE RIVER.
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
N. Y. Yevtushenko, N. V. Bren, and Y. M. Sytnik.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 119-125, 1990. 1 fig, 2 tab, 6 ref.

Descriptors: *Bioaccumulation, *Danube River, *Heavy metals, *Invertebrates, *Path of pollutants, Cadmium, Cobalt, Copper, Iron, Lead, Manganese, Nickel, Shellfish, Tissue analysis, USSR, Zinc.

In this paper an attempt is made to illustrate the peculiarities of heavy metal bioaccumulation by invertebrates inhabiting the Kiliya delta of the Soviet portion and the lower course of the Danube River. Field-season studies were conducted along the Soviet stretch of the Danube from 1986-1987 and in March 1988. Eight metals were detected (Cu, Zn, Cd, Mn, Fe, Pb, Co, Ni) in tissues of invertebrates. Substantial differences were observed in the accumulation of heavy metals by the different species. The tissues of invertebrates in the region tended to accumulate iron, manganese, copper and zinc, but also accumulated cadmium and cobalt in substantially lower amounts. The regularity in bioaccumulation of heavy metals by invertebrates in this study has made it possible to use these organisms for bioindicators of heavy metals in this water. The measurements indicate the fact that both the shells and the soft tissues of this group of invertebrates also accumulated iron, zinc, manganese and lead intensively. The accumulation levels of heavy metals in soft tissues were substantially higher than in shells. Bioaccumulaton of heavy metals varied greatly between species, and is probably related to the environment, food products and the biological role of the metals in the physiological functions of the organism. The results from the Kiliya delta and the lower course of the Danube generally agree very closely, but the metal content in the tissues of invertebrates from the mouth of the river was somewhat higher. (Agostine-PTT)
W90-08621

NUTRIENT INPUT AND TROPHIC STATUS OF THE 'NEUE DONAU', A HIGH-WATER CONTROL SYSTEM ALONG THE RIVER DANUBE IN VIENNA, AUSTRIA.
Institut fuer Limnologie, Mondsee (Austria).
For primary bibliographic entry see Field 6G.
W90-08623

WATER QUALITY OF THE RIVER SAVA AT THE INFLOW OF A PULP AND PAPER MILL EFFLUENT.
Nis Univ. (Yugoslavia). Inst. for Occupational Safety.
V. V. Cibulic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 189-194, 1990. 5 tab, 3 ref.

Descriptors: *Danube River, *Industrial wastewater, *Pulp and paper industry, *Water pollution sources, Biochemical oxygen demand, Chemical oxygen demand, Dyes, Ecological effects, Organic pollutants, Phenols, Seasonal variation, Self-purification, Wastewater treatment, Water pollution effects.

A pulp and paper mill on the Sava River is a plant for mechanical and chemical wastewater treatment, by flocculation and coagulation with aluminum sulfate. The Sava, which receives these wastewaters, was investigated 6 km downstream from the wastewater inflow in order to determine its capability for self-purification, i.e., to determine the amount of pollution from the pulp and paper mill which had been biochemically degraded over this distance. Assessment of the effects of the mill wastewaters on the Sava was done on the basis of changes in the 13 parameters investigated, which included: flow rate, chemical oxygen demand (COD), temperature, pH, biochemical oxygen demand (BOD), and suspended solids. Two situations were studied: when the treatment plant was in operation, and when it was not working. Results of these investigations indicate that the wastewaters had significant effects on the Sava. COD and BOD were increased and some toxic substances were present at high concentrations, e.g., phenols, oils and grease, and dyestuff. The negative influence of the wastewaters was greater during the summer, at low water levels in the Sava. The Sava is a tributary of the River Danube, into which the pollution from this river finally flows. Regardless of the water flow rates, toxic substances are constantly accumulating, and, as a result, even such large systems as the Danube and the Sava are becoming more and more polluted. (Agostine-PTT)
W90-08630

IMPACT OF THE CHERNOBYL ACCIDENT ON THE RADIOACTIVITY OF THE RIVER DANUBE.
Novi Sad Univ. (Yugoslavia). Inst. of Physics.
L. Conkic, M. Ivo, S. Lulic, K. Kosutic, and J. Simor.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 195-202, 1990. 4 fig, 6 tab, 3 ref.

Descriptors: *Danube River, *Environmental effects, *Nuclear accidents, *Path of pollutants, *Water pollution sources, Aquatic environment, Cesium radioisotopes, Chernobyl, Ecological effects, Hungary, Radioisotopes, Rubidium radioisotopes, USSR, Water pollution effects, Yugoslavia.

Some results of the joint Yugoslav-Hungarian investigations of the radioactivity of the Danube River on the border profile during the period 1978-1988 are presented. From the results of gross beta (Sr-90, H-3) activity and gamma spectroscopy measurements of the water, fish, sediment and algae samples obtained before and after the Chernobyl accident, the long-term impact of that accident on the river ecosystem is determined. When considering the long term effects of a sudden contamination on an ecosystem, the elimination rate of the contaminant is of primary interest. For radioactive contamination, except for well defined radioactive decay, many unpredictable chemical and biological processes influence the changes in various media. To get a qualitative estimate of the rate of elimination processes of radionuclides from the Danube, an annual mean elimination rate for the i-th radionuclide was calculated from the annual averaged data. From analysis of the data, it was concluded that the annual mean elimination rate of Ru-106, Cs-137, and Cs-134 from all media is 40%/year. The values of the annual equivalent doses from long-lived man-made nuclides in water and fish are estimated, showing an increase by a factor of 5 in the microsievert range due to the Chernobyl accident. Although the statistical error of the estimates is not < 50%, the effect of the Chernobyl contamination on the values of the equivalent doses from the intake of water and fish is visible. Of course, dose variations on the order of microsievert are too small to be considered significant for health risks, because the variations due to natural sources have the same order of magnitude. (Agostine-PTT)
W90-08631

DANUBE FIELD EXCURSION 1988: TRITIUM CONTENT OF RIVER WATER; RADIOACTIVITY OF DANUBE SEDIMENTS.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
D. Rank, F. J. Maringer, W. Papesch, and V. Rajner.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 203-210, 1990. 7 fig, 2 tab, 4 ref.

Descriptors: *Danube River, *Path of pollutants, *Radioactive wastes, *Radioactivity, *Tritium, Bottom sediments, Cesium radioisotopes, Chernobyl, Environmental effects, Fate of pollutants, Nuclear accidents, Nuclear powerplants, Radioisotopes.

Water, sediment, and fish samples were collected during the Danube Excursion 1988, within a coordinated sampling program of the Radiology Working Group of the 'International Arbeitsgemeinschaft Donauforschung'. The H-3 content of the river water and the radioactivity of the bottom sediments were measured. The determined H-3 content of the Danube water corresponds with the long-term trend in the H-3 content of the hydrosphere; the values lie in the range of 3 Bq/kg downstream from Belgrade, while upstream of Bel-

grade they are about 4 Bq/kg. It was only in the wastewater plume of the nuclear power station of Kozloduj that a slightly elevated H-3 value (6 Bq/kg) was found. The content of the sediments of artificial radionuclides was found, at the time of the Danube field excursion, to be almost exclusively due to the radioactive material released following the reactor accident at Chernobyl in April 1986 (mainly Cs-137 and Cs-134). As a consequence of the air currents and precipitation conditions prevailing at the time of the accident, the bottom sediments in the lower course of the Danube were less contaminated than those of the upper course. The fine sediments were found to contain over 3000 Bq/kg of Cs-137 in the upper course of the Danube. (Author's abstract)
W90-08632

RADIOACTIVITY OF SEDIMENTS IN DANUBE RESERVOIRS IN AUSTRIA BEFORE AND AFTER THE CHERNOBYL ACCIDENT.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
D. Rank, F. J. Maringer, and J. Terlunen.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 211-218, 1990. 8 fig, 2 tab, 3 ref.

Descriptors: *Bottom sediments, *Chernobyl, *Dam effects, *Danube River, *Ecological effects, *Radioactive wastes, *Radioisotopes, *Sedimentation, *Water pollution sources, Austria, Fate of pollutants, Nuclear accidents.

A major part of the pollutants transported by rivers are normally adsorbed to the fine-grained particles in suspension. The coupling between pollutants and particles leads to an enrichment of radionuclides in sediments that settle in river reservoirs and lakes. The concentration of radionuclides is a function of grain-size distribution and of the mineralogical composition. Sediment samples from the lock area of each Danube reservoir were collected during the spring of 1985. Three grain size fractions (<20 micrometers, 20-63 micrometers, 63-250 micrometers) were analyzed. On an average the estimated concentration of radionuclides was about 600 Bq/kg for K-40, 50 Bq/kg for Ra-226, and 40 Bq/kg for Th-232. A 17 m drill core was taken from a site 1 km upstream from the Aschach powerplant on the Danube. Analysis of this sediment core showed the history of radionuclide distribution since 1964, the culmination and the end of atomic testing in the atmosphere. This also coincides with the damming of the River Danube at Aschach. The content of Cs-137 in freshly deposited Danube sediments rose by two orders of magnitude following the accident at Chernobyl (i.e. up to 3000 Bq/kg). The Sr-90 is one order of magnitude higher in the post-Chernobyl sediments, but varies considerably (15-30 Bq/kg). (Agostine-PTT)
W90-08633

ESTIMATION OF ENVIRONMENTAL RISK DUE TO POLLUTED SEDIMENT.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W90-08635

EVALUATION OF WASTE WATER POLLUTION.
Ljubljana Univ. (Yugoslavia). Faculty of Natural Sciences and Technology.
For primary bibliographic entry see Field 5A.
W90-08638

AUTOMATIC WARNING STATIONS, RECENT SERIOUS INDUSTRIAL RIVER POLLUTION INCIDENTS, AND PREDICTION MODELS OF POLLUTANTS PROPAGATION-SOME EUROPEAN EXAMPLES.
Compagnie Generale des Eaux, Paris (France).
For primary bibliographic entry see Field 5A.
W90-08640

5C. Effects Of Pollution

DEVELOPMENT OF CRITICAL LIFE STAGE ASSAYS: TERATOGENIC EFFECTS OF ASH BASIN EFFLUENT COMPONENTS ON FRESHWATER FISH, GAMBUSIA AFFINIS AND DAPHNIA.
Voorhees Coll., Denmark, SC.
M. S. Guram, and B. Boatwright.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-012492. Price codes: A03 in paper copy, A01 in microfiche. Report No. DOE/SR/18001--2, April 17, 1989. 22p. DOE Contract DOE/SR/18001-2.

Descriptors: *Bioindicators, *Daphnia, *Fertility, *Gambusia, *Life history studies, *Water pollution effects, Ash Basins, Biological studies, Brown Pond, Duncans Pond, Edgar Pond, Fish, Lebbys Pond, Par Pond, Population dynamics, Risher Pond, Water analysis.

A research project is being conducted to establish a method for describing and evaluating the reproductive level of the Gambusia in the natural state, i.e., non-laboratory establishment of pregnancy. An additional aspect of the overall problem of establishing the natural level of the fertility of free ranging fish has been initiated with the inclusion of another Savannah River Plant (SRP) pond, (Par Pond), and three non-SRP ponds (Edgar Brown Pond, Lebby's Pond, Duncan's Pond) to the previously studied ponds (Ash Basin and Risher Pond). It was believed that it was necessary to have a wider range of environments than that provided by a single comparison. The preliminary results of this expanded survey indicate that this assumption is correct. Data collected from the three SRP ponds appear to indicate that females taken from these ponds deliver fewer fry per female (av. of females of three SRP ponds = about 14/female) than those females taken from non-SRP ponds (av. of females of three non-SRP ponds = about 46/female). While those differences appear to be significant, the number of females taken from non-SRP ponds is limited. Additionally, the data from the three SRP ponds are each fairly similar to each other. By contrast, non-SRP ponds also are similar to each other, but the fry/female average is apparently much higher in all three non-SRP ponds than that found in the SRP ponds. Collectively, these observations tend to give a consistent pattern to the data. However, additional data are required to establish whether or not these relationships are accurate. These determinations (year to year variation in one SRP pond, variation between SRP ponds, variations between SRP and non-SRP ponds) are necessary before additional manipulations and experimental procedures can be carried out on any one pond in any one area. These variations, when determined, will allow the investigators to distinguish between 'natural variation' and any differences in either reproductive parameters or embryonic developmental abnormalities. Results of water analysis have not implicated any specific organic or inorganic pond component that would be a major determinant of the observed fertility patterns. (Lantz-PTT)
W90-07511

AQUATIC ECOTOXICOLOGY: FUNDAMENTAL CONCEPTS AND METHODOLOGIES. VOLUME I.
For primary bibliographic entry see Field 5B.
W90-07522

FUNDAMENTAL CONCEPTS IN AQUATIC ECOTOXICOLOGY.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
A. Boudou, and F. Ribeyre.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 35-75, 17 fig, 1 plate, 94 ref.

Descriptors: *Aquatic environment, *Fate of pollutants, *Path of pollutants, *Toxicity, *Toxicology, *Water pollution effects, Bioaccumulation, Bioavailability, Chemical interactions, Ecological effects, Limnology, Metals, Organic pollutants, Speciation.

A synthesis has been developed that covers the principal processes that enable toxicants to enter freshwater ecosystems, the distribution of these toxicants in the different compartments of the biotope (aquatic phase, suspended matter, sediments), their accumulation in living beings, and their transfer within the trophic networks. All these processes are at the origin of the dysfunctions which affect ecosystems, dysfunctions of varying degrees of severity and duration, depending on the level of contamination, the scale of the effects, and capacity of the systems concerned to adapt or recuperate. The role of the chemical fate of toxicants in biotopes and biocenoses is paramount, both for metal pollutants and organic products: chemical speciation, complexation reactions with the suspended matter and the sediments, chemical transformations, bioaccumulation, and biodegradation. On it depend the bioavailability of contaminants and their biouptake by living beings. The majority of ecotoxicological processes are associated with reactions occurring at the interfaces between the aquatic phase, the atmosphere, suspended matter, sediments, and organisms (biological barriers and cell membranes). Because of the wide-ranging aims of ecotoxicology, this discipline involves a vast area of research. The mechanisms and effects observed on the scale of ecosystem or even ecosphere are the combined result of an almost infinite number of processes which can be observed at lower levels, from the atomic and molecular structure up through the different biological integration levels. (See also W90-07522) (Lantz-PTT)
W90-07525

POLLUTION OF THE HYDROSPHERE BY GLOBAL CONTAMINANTS AND ITS EFFECTS ON AQUATIC ECOSYSTEMS.
Paris-11 Univ., Orsay (France). Lab. de Zoologie et d'Ecologie.
For primary bibliographic entry see Field 5B.
W90-07530

'ENCLOSURE' METHOD: CONCEPTS, TECHNOLOGY, AND SOME EXAMPLES OF EXPERIMENTS WITH TRACE METALS.
Commission of the European Communities, Ispra (Italy). Environmental Inst.
For primary bibliographic entry see Field 7B.
W90-07534

OUTDOOR PONDS: THEIR USE TO EVALUATE THE HAZARDS OF ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS.
Shell Research Ltd., Sittingbourne (England). Sittingbourne Research Centre.
N. O. Crossland, and D. Bennett.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 273-296, 9 fig, 3 tab, 31 ref.

Descriptors: *Experimental design, *Field tests, *Organic compounds, *Ponds, *Toxicity, *Toxicology, *Water pollution effects, Chlorinated hydrocarbons, Dissolved oxygen, Ecological effects, Herbicides, Organophosphorus pesticides, Pesticides, Population dynamics, Stress.

Outdoor experimental ponds, if properly constructed and managed, may be regarded as realistic replicas of larger, natural aquatic ecosystems. They become naturally colonized by bacteria, fungi, algae, macrophytes, and invertebrates, and they should be capable of supporting small populations of fish. Thus, they contain all, or nearly all, of the components of larger, real-world systems and, like their natural counterparts, their structure and function is regulated by interactions between their component parts and the external environment. Therefore, the outdoor experimental pond provides a more realistic experimental unit than is possible to achieve in the laboratory. In ecotoxicology the most important advantage of a pond study, compared with laboratory or microcosm studies, is that it is possible to study effects of

contaminants on populations of various species under conditions of real-world exposure. On the basis of data obtained in the laboratory there is generally more uncertainty involved in predicting chemical fate than in predicting biological effects. Differences between toxicity in the laboratory and biological effects in the field can often be attributed to the action of the environment on the chemical. Therefore, it is important to carry out fate studies in parallel with biological studies. Other advantages of pond studies are that it is possible: (1) to obtain data for species that are not easily maintained in the laboratory; (2) to study indirect effects, such as predator-prey interactions, effects on dissolved oxygen (DO) concentrations, and algal blooms; and (3) to study the rate of recovery of populations from the effects of stress. The construction, experimental design, monitoring, sampling, and management of outdoor experimental ponds is described. Pond experiments to assess the hazard of acute toxicity are illustrated in two case studies: (1) the fate and effects of a pyrethroid insecticide, cypermethrin; and (2) the fate and effects of the organophosphorus insecticide, methyl parathion. The use insecticide, methyl parathion. The use of pond experiments to assess the hazard of chronic toxicity is also illustrated by two studies: (1) the fate and effects of PCP (pentachlorophenol); and (2) the fate and effects of DCA (dichloroacetic acid). (See also W90-07522) (Lantz-PTT)
W90-07535

ARTIFICIAL STREAMS IN ECOTOXICOLOGICAL RESEARCH.
Clemson Univ., SC. Dept. of Biological Sciences.
For primary bibliographic entry see Field 7B.
W90-07536

AQUATIC ECOTOXICOLOGY: FUNDAMENTAL CONCEPTS AND METHODOLOGIES. VOLUME II.
For primary bibliographic entry see Field 5B.
W90-07537

TROPHIC CHAINS AND EXPERIMENTAL ECOSYSTEMS: STUDY OF BIOACCUMULATION AND TRANSFER PROCESSES.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
For primary bibliographic entry see Field 5B.
W90-07538

STANDARDIZED AQUATIC MICROCOSM-DEVELOPMENT AND TESTING.
Washington Univ., Seattle. School of Fisheries.
F. B. Taub.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 47-92, 10 fig, 5 tab, 60 ref. FDA Contracts 223-76-8348, 223-80-2352, and 223-83-7000.

Descriptors: *Ecological effects, *Experimental design, *Toxicology, *Water pollution effects, Antibiotics, Copper, Data acquisition, Dimilin, Extrapolation, Malathion, Standardized Aquatic Microcosm, Streptomycin, Sulfates, Triethylene glycol.

Extrapolation between different ecosystems is an uncertain undertaking, although ecosystems with the same trophic organization and limiting factors are likely to respond in similar manners. If so, it is then important to note that these microcosms have abundant algal nutrients and lack predators of Daphnia. Algal blooms would not be likely to happen in ecosystems that had low algal nutrients, that had predator-controlled grazer populations, or in which some component of the grazer trophic level was not sensitive to the toxic test chemical. Therefore, no single test system can be predictive of all natural ecosystems, although the Standardized Aquatic Microcosm (SAM) can provide information on the interactions between algae, grazers, and nutrient recycling from which extrapolations might be made to similar trophic structures, and with the inclusion of other processes, to different types of communities. The dominance relationships

within these microcosms depends on the balance of birth and death rates and the competition with other organisms. Even if the same species occur in other communities, the effects of a test chemical may differ because of the different balance interactions. Another limitation of the method is the potential for contaminating organisms to become established and to replace the intended biota. The method is illustrated by experiments involving the responses of microcosms to streptomycin, malathion, triethylene glycol, dimilin, and copper sulfate. The ecological interactions within and between nutrient/algae/grazer trophic levels were similar to those of temperate lakes; the absence of a predator trophic level must be considered in extrapolating to natural ecosystems that are predator controlled. The replication within treatment groups is good. This SAM extrapolation design is far more convincing than before/after or unreplicated experiments for which it might be argued that differences were caused by random or unrelated causes. Although no single ecosystem is likely to be predictive of all, the SAM do display behavior similar to those ecosystems with similar tropic structure treated with similar chemicals. Extrapolation to specific natural ecosystems requires information on the trophic structure and controlling factors of those ecosystems. (See also W90-07537) (Lantz-PTT)
W90-07539

SINGLE SPECIES TOXICITY TESTS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
D. Pascoe, and R. W. Edwards.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 93-126, 12 fig, 4 tab, 203 ref.

Descriptors: *Bioindicators, *Ecotoxicology, *Experimental design, *Toxicity, *Toxicology, Biological studies, Lethal limit, Water pollution effects.

Traditionally, fish have been the principal group used in aquatic toxicology. The selection of test species depends very much on the objectives of the investigation. For regulatory purposes clear guidelines are provided, and in toxicity tests carried out for nonregulatory purposes, the choice of species may also be limited. Species to be used in toxicity tests are obtained from two principal sources: (1) an uncontaminated but 'at risk' site; and (2) the culture of asexually reproducing animals, such as some crustaceans, rotifers, and ostracods. Some of the principal groups and species used in toxicity tests include: bacteria, algae, higher plants, protozoa, coelenterata, platyhelminths, rotifera, annelida, crustacea, insecta, mollusca, and fish. During an acute toxicity test, animals are normally exposed to a series of toxicant concentrations, which on the basis of simple range finding tests, are expected to give responses from 0 to 100%. In other tests, particularly chronic sublethal investigations and those involving real pollution incidents, the time-related response to a single concentration may also be assessed. Tests are normally classified as being acute, subacute, or chronic--a terminology derived from mammalian toxicology and referring to the anticipated response time rather than the nature of the response, which may be lethal or sublethal whatever the time scale. Although frequently considered as such, toxicity, by whatever means it is assessed (LC sub 50, LT sub 50 thresholds, pathological change) is not a biological constant, but varies with numerous factors which may increase or decrease the recorded response. The literature abounds with reports of such modifying conditions and these can be classified into two major groups, factors extrinsic, e.g. water quality parameter and intrinsic to the organism. Intrinsic factors include development stage, previous contact with the test compounds, and stressors. (See also W90-07537) (Lantz-PTT)
W90-07540

FISH AS 'BIOLOGICAL MODEL' FOR EXPERIMENTAL STUDIES IN ECOTOXICOLOGY.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
A. Boudou, and F. Ribeyre.

IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 127-162, 13 fig, 1 tab, 146 ref.

Descriptors: *Bioindicators, *Ecotoxicology, *Experimental design, *Fish, *Model studies, *Toxicology, *Water pollution effects, Biological models, Biological studies, Fish physiology, Genotoxicity, Laboratory methods, Lethal limit, Mortality, Toxicity.

The main factors (abiotic factors, contamination factors, and biotic factors) used in the field of ecotoxicology in order to understand, at laboratory level, the processes by which fish are contaminated, and the resulting effects are reviewed. A great deal of research work has been carried out on fish, especially in relation to their economic importance and their ecological and biological significance and because they are relatively easy to use in experimental work. This is linked with the fact that there are very many different approaches to the subject, depending on one's objectives and the methodologies used. It would be virtually impossible to produce an exhaustive and coherent classification of these different objectives. They do, however, give an indication of the main concerns in the ecotoxicological approach to the contamination of aquatic systems: processes of bioaccumulation and transfer, effects on structures and biological functions, basic viewpoints and applications, among other considerations. With each of these objectives, a fairly specific set of methodologies is associated. Each methodology is characterized by its own biological system (species, stage of development, sex), by its contamination conditions (acute, chronic, direct or trophic routes, types of contaminants), and by its analytical levels and criteria (population to molecule; toxicant concentration and content; mortality, physiological dysfunctions, ethological damages, genotoxic effects, and others). (See also W90-07537) (Lantz-PTT)
W90-07541

'PHYTOPLANKTON MODEL' IN ECOTOXICOLOGY.
Station Zoologique, Villefranche-sur-Mer (France).
S. Puiseux-Dao.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 163-185, 7 fig, 1 tab, 108 ref.

Descriptors: *Bioindicators, *Ecotoxicology, *Model studies, *Phytoplankton, *Toxicity, *Toxicology, *Water pollution effects, Algae, Biological studies, Literature review, Metals, Physiology, Xenobiotics.

Phytoplankton productivity has been recognized as an essential constituent of aquatic food chains. Numerous studies have analyzed the effects of environmental factors on algal growth. Pollutants due to human activity can disturb phytoplankton behavior at least in coastal and freshwater ecosystems. In addition, their possible accumulation in algal cells, and their subsequent effects on food chains remain largely unpredictable. Some phytoplankton species have been extensively used as experimental models for studying the cell cycle. Synchronized cultures of these algae offer the potential to increase our understanding of pollutant impact on algal production. Moreover, because eukaryotic cells have fundamentally similar patterns of functioning, results obtained with algae may be of interest for toxicologists working on animal or plant systems. The aim of this review is to point out prominent features and problems of toxicology associated with eukaryote phytoplankton with no attempt to give an exhaustive account of relevant literature. Several points arise: (1) most of the authors have investigated the effects of xenobiotics on phytoplankton productivity and the accumulation of toxic substances in these unicellular algae; (2) although the metabolization capabilities of algal phytoplankton are low, the risks of organic pollutant accumulation does not appear too severe since most of the time these substances are lipophilic and can, thus, be stored reversibly in

the lipid phase; (3) xenobiotic toxicity to phytoplankton algae varies greatly, and depends upon the species and environmental conditions. In general for a monospecific algal population, at normal pollution levels or even at sublethal doses, only a fraction of the cells may die and the surviving cells can restore a dense population quite rapidly when the conditions return to normal; (4) algal resistance to pollutants varies within a given species, as shown when comparing the sensitivity to chemicals of the same algae from open sea or estuarine areas; (5) when death does occur, xenobiotics result in changes to the algal physiology. (See also W90-07537) (Lantz-PTT)
W90-07542

ECOTOXICITY TESTING USING AQUATIC BACTERIA.
Centre des Sciences de l'Environnement, Metz (France). Dept. of Microbiology.
J. C. Block, P. Bauda, and C. Reteuna.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 187-210, 7 fig, 10 tab, 99 ref.

Descriptors: *Aquatic bacteria, *Bacteria, *Bioindicators, *Ecotoxicology, *Testing procedures, *Toxicity, *Toxicology, *Water pollution effects, Bioassay, Laboratory methods, Literature review, Microbiological studies.

Aquatic ecotoxicity tests measure the toxicity of chemical products on living organisms representing various trophic levels of the food chain in natural or man-modified ecosystems. Because of the adaptation ability of bacteria, the protective effect of their envelopes, and other reasons, bacteria can be considered to be less sensitive to toxicants than other biological systems. On the other hand, as bacteria represent a large part of the biomass and are involved in the biotransformation of molecules and wastes and the biogeochemical cycles of the matter (C, N, S), tests of ecotoxicity on bacteria are worthwhile. Bacterial tests are not used enough in the battery of tests demanded by legislation (apart, of course, from those concerning mutagenesis). The qualities and limits of the more common bacterial toxicity tests are emphasized. After the characteristics of the bacterial cells and the parameters and tests that cause a cytotoxic effect are examined, the conditions required for the implementation of these tests are discussed, because these conditions determine the response of the test and its meaning. About 20 tests or groups of tests on bacterial ecotoxicity are available for assessing the toxic risks of pure chemical molecules or complex mixtures. Choosing one test depends on both objective and subjective criteria: the sensitivity, the repeatability, the simplicity, the meaning of the test, (understanding of the main mechanisms), investments, time to completion of the test. Among the different tests, inhibition of bioluminescence for a rapid screening, then dehydrogenase inhibition, and finally inhibition of the oxygen consumption which may be applied to any type of sample (lab or field) are the most interesting ones. In this way, bacterial ecotoxicity bioassays are as sensitive as other available biological models. (See also W90-07537) (Lantz-PTT)
W90-07543

CONTAMINATION OF AQUATIC SYSTEMS AND ITS GENETIC EFFECTS.
Institut de Recherches Scientifiques sur le Cancer, Villejuif (France). Cancerogenese Experimentale et Toxicologie Genetique.
I. Chouroulinkov, and A. Jaylet.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 211-235, 5 fig, 2 tab, 47 ref.

Descriptors: *Ecosystems, *Genetics, *Toxicity, *Toxicology, *Water pollution effects, Chromosomes, DNA, Experimental design, Literature review, Mutagenicity.

Chemical pollutants of freshwater (fresh surface and groundwater), and fundamental aspects of genotoxic and mutagenic effects are discussed. Studies

which have used aquatic organisms to evaluate the genotoxic and mutagenic potentials of physical (X-rays) and chemical agents on certain lake, river, or drinking waters are reviewed briefly. If the genetic effects of aquatic contaminants are considered, aquatic models have been used and proposed for the study of unscheduled DNA synthesis (UDS)(genotoxic effect), in vivo gene mutation (specific locus), induction of sister chromatid exchange, chromosomal aberration induction in vivo and in vitro, micronucleus induction on Pleurodeles (larvae) and in plants, and lethal recessive mutation. This range of endpoints covers the tests required to check the mutagenic potential of chemical products. (See also W90-07537) (Lantz-PTT)
W90-07544

LABORATORY AND FIELD TECHNIQUES IN ECOTOXICOLOGICAL RESEARCH: STRENGTHS AND LIMITATIONS.
National Fisheries Contaminant Research Center, Columbia, MO.
For primary bibliographic entry see Field 7B.
W90-07545

APPLIED ECOTOXICOLOGY AND METHODOLOGY.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
J. Cairns.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 275-290, 1 fig, 49 ref.

Descriptors: *Ecotoxicology, *Experimental design, *Laboratory methods, *Toxicology, *Water pollution effects, Bioindicators, Biological studies, Lethal limit, Monitoring, Mortality, Test method, Toxicity, Water quality.

The purpose of applied ecotoxicology is predicting damage to natural systems and the organisms that inhabit them. This should be done before a chemical is released into the environment. These predictive toxicity tests might be conveniently divided into range-finding test (Tier 1) to indicate the concentration at which all specimens are killed (or at which 100% respond if some parameter other than lethality is used) and that concentration that produces no response; the more definitive acute and chronic predictive tests (Tier 2) that follow range-finding tests and are usually designed to determine the LC sub 50 and to identify with more precision the response gradient in a graded series of concentrations so that the no-response and 100%-response threshold, as well as some intermediate response points, can be identified with more precision than the range-finding test is intended to produce. These laboratory tests should be followed by validating or confirming tests (Tier 3) carried out in the natural system at risk or a surrogate of it as a form of error control to test predictions based on laboratory tests alone. Finally, a biological monitoring system (Tier 4) might be installed to provide evidence on a continuous basis that the predetermined quality control conditions are being met. Both range-finding and predictive toxicity testing are quite common for substances being discharged into aquatic systems, but confirming or validating tests and continuous biological monitoring are not. The need for strategy changes to improve the scope and accuracy of single-species toxicity tests in combination with tests at higher levels of biological organization is discussed. (See also W90-07537) (Lantz-PTT)
W90-07547

SHORT-TERM METHODS FOR ESTIMATING THE CHRONIC TOXICITY OF EFFLUENTS AND RECEIVING WATERS TO FRESHWATER ORGANISMS. SECOND EDITION.
Environmental Monitoring Systems Lab., Cincinnati, OH.
C. I. Weber, W. H. Peltier, T. J. Norberg-King, W. B. Horning, and F. A. Kessler.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-207013. Price codes: A10 in paper copy, A01 in microfiche.

Report No. EPA/600/4-89/001, March 1989. 249p, 2 fig, 2 tab, 63 ref, 9 append.

Descriptors: *Laboratory methods, *Receiving waters, *Testing procedures, *Toxicity, *Toxicology, *Water pollution effects, Biological studies, Biological tests, Chlorophyta, Cladocerans, Data acquisition, Minnow.

This manual describes short-term (four-day to seven-day) methods for estimating the chronic toxicity of effluents and receiving waters to the fathead minnow (Pimephales promelas), a cladoceran (Ceriodaphnia dubia), and a green alga (Selenastrum capricornutum). Also included are guidelines on laboratory safety, quality assurance, facilities and equipment, dilution water, effluent sampling and holding, data analysis, report preparation, and organism culturing and handling. Examples of the statistical analysis of test data are included with the methods. Supplementary information on statistical techniques for test design and analysis of toxicity test data is provided in the Appendices. (Author's abstract)
W90-07558

MONTE CARLO ANALYSIS AND BAYESIAN DECISION THEORY FOR ASSESSING THE EFFECTS OF WASTE SITES ON GROUNDWATER, I: THEORY.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
C. M. Marin, M. A. Medina, and J. B. Butcher.
Journal of Contaminant Hydrology JCOHE6, Vol. 5, No. 1, p 1-13, December 1989. 5 fig, 11 ref. Water Resources Research Institute of the University of North Carolina and the Division of Environmental Management, Department of Natural Resources and Community Development (State of North Carolina) Grant No. 87-17-70058.

Descriptors: *Bayesian decision theory, *Groundwater pollution, *Model studies, *Monte Carlo method, *Risk assessment, *Waste disposal, *Water pollution effects, Algorithms, Hazardous waste disposal, North Carolina.

State agencies face a formidable task when addressing the difficult and increasingly important problem of groundwater quality management. Faced with such a difficult challenge, it is tempting to either postpone a decision until more knowledge is gained, or proceed with the simplest of analyses. Decision analysis was developed precisely for the challenge of trading off the cost of additional information against the risk of uncertain decisions. Analysis of the risk associated with a given hazardous waste site requires the application of a contaminant transport model, together with an analysis of the risk associated with model predictions. Monte Carlo simulation techniques provide an explicit format for deriving the output distributions for deterministic models with random input parameters. The technique is incorporated into a sequential Bayesian risk methodology to address the problem of permitting waste sites under conditions of imperfect information. A series of decision analysis flow diagrams are used to outline the general architecture of the advisory system and the algorithm used to evaluate each site. Components of the advisory sequence include data handling and analysis, model selection and use, risk/error analysis, sampling design, and permitting decisions. The sequential algorithm is a set of increasing refined criteria used to categorize the regulatory status of a site. The algorithm is sufficiently general that it can be adapted to accommodate any specific groundwater contaminant transport model or site configuration. The methodology described here is being incorporated into an advisory computer system for North Carolina groundwater quality modeling and management needs. (See also W90-07615) (Tappert-PTT)
W90-07614

MONTE CARLO ANALYSIS AND BAYESIAN DECISION THEORY FOR ASSESSING THE EFFECTS OF WASTE SITES ON GROUNDWATER, II: APPLICATIONS.
Duke Univ., Durham, NC. School of Forestry and

Environmental Studies.
For primary bibliographic entry see Field 2F.
W90-07615

THREE STUDIES USING CERIODAPHNIA TO DETECT NONPOINT SOURCES OF METALS FROM MINE DRAINAGE.
Environmental Protection Agency, Denver, CO. Region VIII.
For primary bibliographic entry see Field 5A.
W90-07621

IN VITRO EFFECTS OF THREE ORGANO-PHOSPHORUS INSECTICIDES ON KINETIC CONSTANTS OF ACETYLCHOLINESTERASE IN A FRESHWATER TELEOST, CLARIAS BATRACHUS (LINN).
Kakatiya Univ., Warangal (India). Dept. of Zoology.
V. J. Shobha Rani, and C. Janaiah.
Current Science CUSCAM, Vol. 58, No. 18, p 1048-1051, September 1989. 2 fig, 1 tab, 17 ref.

Descriptors: *Carbamate pesticides, *Fish, *Organophosphorus pesticides, *Path of pollutants, *Pesticide toxicity, *Pesticides, *Water pollution effects, Acetylcholinesterase, Malathion, Methylparathion, Pesticide kinetics, Tissue analysis, Toxicity, Trichlorfon.

It is well known that acetylcholinesterase is the target enzyme of both organophosphorus and carbamate pesticides. The in vitro inhibition kinetics of acetylcholinesterase by trichlorfon, malathion and methylparathion in brain and muscle tissues of the freshwater edible fish Clarias Batrachus (Linn.) were studied. Fish weighing 30-40 g and 20 cm in length were collected from the local market and acclimatized to laboratory conditions for about two weeks. Acetylcholinesterase was assayed in the presence of different concentrations (2-20 micromoles) of trichlorfon, malathion and methylparathion individually to determine the 50% inhibitory concentration values. Double reciprocal plots were prepared and kinetic constants were calculated. Fifty percent inhibitory concentration in the brain acetylcholinesterase for trichlorfon was 4 micromoles, for malathion was 10, and methylparathion was 12 micromoles. In the case of muscle acetylcholinesterase 50% inhibitory concentration was 8 micromoles for trichlorfon, 12 for malathion, and 15 micromoles for methylparathion. Increases in kinetics suggests decreased affinity of the enzyme for the substrate and also decreased rate of breakdown of the enzyme-substrate complex. The three organophosphorus compounds studies exert a competitive type of inhibition on acetylcholinesterase. (Mertz-PTT)
W90-07650

SIMULATION MODELLING OF THE EFFECTS OF OIL SPILLS ON POPULATION DYNAMICS OF NORTHERN FUR SEALS.
Applied Science Associates, Inc., Narragansett, RI.
M. Reed, D. P. French, J. Calambokidis, and J. C. Cubbage.
Ecological Modelling ECMODT, Vol. 49, No. 1/2, p 49-71, December 1989. 10 fig, 2 tab, 24 ref. Minerals Management Service, Alaska Regional Office Contract No. 14-12-0001-30145.

Descriptors: *Model studies, *Oil spills, *Population dynamics, *Seals, *Simulation analysis, *Water pollution effects, Data interpretation, Ecological effects, Migration, Mortality, Population density.

Models of population dynamics and migration were developed and combined with an oil spill simulation model to determine the effects of potential oil spills on the Pribilof Island fur seal (Callorhinus ursinus) population. In the population dynamics model, mortality of pups on land and juveniles up to 2 years of age is density-dependent, while that of older seals is age and sex-specific and constant at all population sizes. Movement patterns of seals within the Bering Sea are functions of date, sexual status and age, conforming to probability distributions based on field observations of their

movements and timing. Two simulations of hypothetical 10,000-barrel oil spills were performed. One occurs near Unimak Pass during the peak migration of pregnant females to the Pribilof rookeries, oiling 3% of the total female population. The other occurs near St. Paul Island during the pupping season, and oils 2-4% of the female population. By comparison, about 16% of females die from natural causes each year. Depending on the assumed oil-induced mortality rate in the range 25-100%, effective recovery of the population from these spills (such as, the number of years before the oil-affected population numbers were within 1% of the non-affected population numbers) took 0-25 years. (Author's abstract)
W90-07654

METAL HOMEOSTASIS AND METALLOTHIONEIN INDUCTION IN RAINBOW TROUT HEPATOCYTES EXPOSED TO CADMIUM.
Quebec Univ., Montreal. Dept. de Chemie.
R. Gagne, M. Marion, and F. Denizeau.
Fundamental and Applied Toxicology FAATDF, Vol. 14, No. 2, p 429-437, February 1990. 7 fig, 27 ref.

Descriptors: *Cadmium, *Metallothioneins, *Path of pollutants, *Trout, *Water pollution effects, Biochemistry, Chemical analysis, Copper, Fish physiology, Heavy metals, Toxicity, Zinc.

The cellular effects of Cd and metallothionein metabolism using a primary cell culture system composed of isolated rainbow trout (Salmo gairdneri) hepatocytes was investigated. The cells were exposed to 89 nM Cd for 0, 5, 12, 20, 25, 30, 35, and 40 hours at 15 C. The concentration of Cd used did not cause significant cell damage, as estimated by lactate dehydrogenase release into the extracellular medium. However, the presence of the metal led to increased cellular levels of calcium within the first 12 hours of incubation. Later, these returned to control values and remained as such for the rest of the examination period. A transient increase in intracellular copper and zinc also occurred during the initial incubation period. In parallel, the hepatocytes were found to accumulate appreciable quantities of Cd, a significant proportion of which were detected in the cytosol. Distribution profiles of cytosolic Cd obtained through Sephadex G-75 chromatography showed that the metal was associated mainly with the high-molecular-weight and middle-molecular-weight protein fractions. At 12 hours, there was a maximum in the proportion of Cd in the middle-molecular-weight fractions, which was accompanied by a decrease in the proportion of Cu in the same reactions. At this time, cellular metallothionein exhibited the highest levels. Middle-molecular-weight fractions were further resolved using anion-exchange chromatography. Although Cd was present in the peaks corresponding to metallothionein, the data indicated that these peaks also contained detectable amounts of Cu and Zn. (Author's abstract)
W90-07659

ACUTE TOXICITY AND BIOCONCENTRATION OF LINDANE AND DELTAMETHRIN BY RANA TEMPORARIA TADPOLES AND MOSQUITOFISH (GAMBUSIA AFFINIS) (TOXICITE AIGUE ET BIOCONCENTRATION DU LINDANE ET DE LA DELTAMETHRIN PAR LES TETARDS DE RANA TEMPORARIA ET LES GAMBUSIES) (GAMBUSIA AFFINIS).
Paris-11 Univ., Orsay (France). Lab. de Zoologie et d'Ecologie.
E. Thybaud.
Hydrobiologia HYDRB8, Vol. 190, No. 2, p 137-145, February 1990. 4 fig, 5 tab, 28 ref. English summary.

Descriptors: *Bioaccumulation, *Bioassay, *Frogs, *Insecticides, *Lindane, *Pesticide toxicity, *Toxicity, Gambusia, Lethal limit, Metabolism, Mortality, Population exposure, Water pollution effects.

Acute toxicity and bioconcentration capacities of lindane and deltamethrin were studied in Rana temporaria tadpoles and in mosquitofish. These studies show that the toxicity of deltamethrin is about 100 to 1000 times greater than that of lin-

dane. For deltamethrin, 24 and 48 hour LC50s for tadpoles were 13.35 and 19.61 micrograms/L and for mosquitofish were between 0.5 and 2 micrograms/L. The corresponding values using lindane were 8.63 mg/L and 5.88 mg/L for tadpoles, and between 0.10 and 0.20 mg/L for mosquitofish. Bioconcentration factors were very different for these two insecticides. Lindane, which is a stable, hydrophobic chemical with low volatility and is poorly metabolized, has a considerable bioconcentration factor in either static or flowthrough exposure systems. For deltamethrin, a quickly metabolized molecule, this factor is weak to null. Moreover, a comparison of various methods of exposure (static or flowthrough systems) showed that the experimental conditions of exposure to insecticide strongly influences the concentration in the tested species. (Author's abstract)
W90-07695

RELATIVE EFFECTS OF ENRICHMENT AND CLIMATE CHANGE ON THE LONG-TERM DYNAMICS OF DAPHNIA IN ESTHWAITE WATER, CUMBRIA.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
D. G. George, D. P. Hewitt, J. W. G. Lund, and W. J. P. Smyly.
Freshwater Biology FWBLAB, Vol. 23, No. 1, p 55-70, February 1990. 9 fig, 1 tab, 59 ref.

Descriptors: *Daphnia, *England, *Eutrophic lakes, *Limnology, *Seasonal variation, *Water pollution effects, *Zooplankton, Algae, Climates, Cyanophyta, Diatoms, Nitrogen, Nutrients, Phosphorus, Population dynamics, Time series analysis, Weather.

The factors influencing the seasonal and interannual variations in the numbers of Daphnia hyalina in Esthwaite Water, England between 1956 and 1972 were analyzed. Esthwaite Water has always been eutrophic, but the phosphorus and nitrogen loadings to the lake increased significantly in the mid 1960s. The birth rate of the Daphnia was constrained by temperature from January to April and from October to December. At other times their rate of increase was governed by the relative abundance of edible and inedible algae. Daphnia could only reproduce in late summer when there were periodic regrowths of edible algae. Such regrowths were most likely to occur when there had been some entrainment of deep nutrients by episodic wind mixing. Calm weather encouraged the growth of blue-green algae that effectively 'blocked' the development of Daphnia for the remainder of the summer. The factors that controlled the seasonal dynamics of the Daphnia also influenced the average number recorded in a particular year. This 'weather' effect was highlighted by comparing de-trended time-series of Daphnia and Aphanizomenon numbers with a simple measure of thermocline stability. De-trending removed the superimposed effects of progressive enrichment and revealed a 10-year cycle of thermocline stability that matched the temperature cycle recently reported in Windermere. These cycles are related to the movement of weather systems in the Atlantic and so could change if the pattern of atmospheric circulation is altered by global warming. (Author's abstract)
W90-07713

CHANGES IN PHYTOPLANKTON OVER VARIOUS TIME SCALES IN A SHALLOW, EUTROPHIC: THE LOCH LEVEN EXPERIENCE WITH SPECIAL REFERENCE TO THE INFLUENCE OF FLUSHING RATE.
For primary bibliographic entry see Field 2H.
W90-07714

TOXIC CYANOBACTERIA (BLUE-GREEN ALGAE) IN FINNISH FRESH AND COASTAL WATERS.
Helsinki Univ. (Finland). Dept. of Microbiology.
K. Sivonen, S. I. Niemela, R. M. Niemi, L. Lepisto, and T. H. Luoma.
Hydrobiologia HYDRB8, Vol. 190, No. 3, p 267-275, February 15, 1990. 2 fig, 7 tab, 39 ref.

Group 5C—Effects Of Pollution

Descriptors: *Algal toxins, *Bioassay, *Cyano-phyta, *Eutrophication, *Finland, *Limnology, *Toxicity, *Water pollution effects, Bacteria, Cattle, Hepatotoxins, Neurotoxins, Pollutant identification.

A survey of the occurrence of toxic blooms of cyanobacteria in Finnish fresh and coastal waters was made during 1985 and 1986. Toxicity of the freeze-dried water bloom samples was tested by mouse-bioassay. Forty-four per cent (83/188) of the bloom samples were lethally toxic. Hepatotoxic blooms (54) were almost twice as common as neurotoxic ones (29). Anabaena was the most frequently found genus in toxic and non-toxic blooms and it was present in all neurotoxic samples. Statistical associations were found between hepatotoxicity and incidence of Microcystis aeruginosa, M. viridis, M. wesenbergii, Anabaena flos-aquae and Anabaena spiroides. Neurotoxicity was statistically associated with Anabaena lemmermannii, A. flos-aquae and Gomphosphaeria naegeliana. Isolation of strains of cyanobacteria confirmed the occurrence of hepatotoxic and neurotoxic strains of Anabaena, as well as hepatotoxic strains of Microcystis and Oscillatoria species. Toxic blooms caused cattle poisonings at three different lakes during the study period. Toxic blooms also occurred in drinking water sources. The study shows that toxic cyanobacteria are more common in Finnish lakes than would be expected on the basis of animal poisonings. (Author's abstract)
W90-07721

STUDY OF THE METAL CONTENT IIN THE WATERS OF THE PROTECTED REGION OF THE JUZERA MOUNTAINS.
Ceske Vysoke Uceni Technicke v Praze. Faculty of Civil Engineering.
M. Mach, J. Zeithammerova, J. Kocica, L. Macek, and A. Grunwald.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 339-344, 1989. 7 fig, 2 tab, 9 ref.

Descriptors: *Acid rain effects, *Czechoslovakia, *Groundwater pollution, *Stream pollution, *Water pollution, *Water pollution sources, *Water quality trends, Aluminum, Bogs, Cadmium, Hydrogen ion concentration, Iron, Leaching, Manganese, Pollutants, Reservoirs, Streams, Water treatment plants, Zinc.

One of the consequences of acid deposition is the gradual rise of metal content in surface and groundwaters. The protected region of the Jizera Mountains, Czechoslovakia, has been seriously damaged by acid deposition mainly in the last few years. Study of the metal content in water of the Jizera Mountain region was carried out between 1982 and 1986 on ten different localities: eight streams, raw water taken from the Sous Reservoir, and treated water from a water treatment plant. The content of some metals in the waters rose considerably during spring thaw. Aluminum, iron, zinc, manganese and cadmium from atmospheric solid deposition is easily dissolved in waters with a low pH. Lowest pH values were found during the spring thaw; whereas highest values were seen in summer. This may be influenced by leaching from peat-bogs and moors. The relation between pH and metal content in water was demonstrated in 1986 during the summer, when a drop in pH caused increases in aluminum, iron, zinc, and manganese. The Kamenice river had the lowest pH of all localities observed. This was probably related to tributary streams flowing from peat-bogs. Higher content of aluminum and manganese compared to waters from other localities. (Mertz-PTT)
W90-07741

CHANGES IN COMMUNITY STRUCTURE AND PRODUCTIVITY OF PHYTOPLANKTON AS INDICATORS OF LAKE AND RESERVOIR EUTROPHICATION.
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
For primary bibliographic entry see Field 2H.
W90-07745

ECOTOXICOLOGICAL TESTS ON BENTHIC ORGANISMS.
Procter and Gamble European Technical Center, Brussels (Belgium).
I. B. Buyle.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 485-491, 1989. 1 fig, 18 ref.

Descriptors: *Benthos, *Chemical industry, *Ecosystems, *Limnology, *Toxicology, *Water pollution effects, Algae, Bioavailability, Chemical effects, Fish, Interstitial water, Path of pollutants, Periphyton, Pollutants, Research facilities, Risk assessment, Sediments, Sorption, Streams, Suspended sediments, Water column.

Ecotoxicological testing aims at determining the effects of a chemical on the environmental compartments affected by the chemical under relevant exposure conditions. Currently, most of the attention of ecotoxicologists looking at the aquatic system goes to organisms living in the water column, and then especially to the most obvious group: fish. Procter and Gamble have invested a lot of effort in the research on potential impact of chemicals on the benthic ecosystem since 1984. Studies using alternative benthic species whose ecology suggest different routes of exposure and potentially increased exposure to sorbed fractions are being conducted. Hazard assessment of sorbed materials involves consideration of four environmental compartments: sediments, suspended solids, overlying water and interstitial water. Research being done in this area aims at the development of a tiered toxicological testing procedure for materials with a potential to sorb onto sediments. Limited evidence suggests that benthic organisms are no more sensitive to contaminants than organisms living in the water column. More work for the determination of bioavailability, fate and behavior of sediment associated chemicals needs to be done. (Mertz-PTT)
W90-07758

TEMPERATURE INCREASE EFFECTS ON ZOOPLANKTON STRUCTURE IN A COOLING RESERVOIR.
LIMNOS S.A., Barcelona (Spain).
M. Alonso.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 503-511, 1989. 4 fig, 2 tab, 14 ref.

Descriptors: *Cooling water, *Limnology, *Population dynamics, *Reservoirs, *Species composition, *Temperature effects, *Thermal pollution, *Zooplankton, Cooling reservoirs, Eutrophic lakes, Heated water, Nuclear powerplants, Rotifers, Spain, Waterfleas.

The zooplankton community changes induced by the increase of the temperature in a cooling reservoir were investigated. The Arrocampo reservoir, built in the Arrocampo stream, belongs to the Tajo basin in Spain. It has 35 cubic Hm of capacity and is used to cool a nuclear power plant. The community structure of zooplankton is very typical of eutrophic (7-270 mg/cubic m of chlorophyll) and not very highly mineralized Spanish reservoirs. It was studied from 1978 to 1986 with monthly sampling, covering the preoperational and the postoperational periods of the plant. The most important changes in the zooplankton induced by the increase of the water temperature are related to the incorporation of species such as the tropicopolitan Ceriodaphnia cornuta and also to the annual succession. In the case of annual succession, some species which were only characteristic of the summer zooplankton during the preoperational period such as Diaphanosoma mongolianum, Brachionus angularis and Hexarthra spp. appear during the whole year during the postoperational period. (Author's abstract)
W90-07760

FAUNA OF THE ZEMBORZYCE RESERVOIR.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
S. Radwan, W. Zwolski, B. Jarzyna, A. Paleolog, and C. Kowalczyk.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 539-547, 1989. 4 fig, 2 tab, 9 ref.

Descriptors: *Aquatic populations, *Limnology, *Poland, *Reservoirs, *Species composition, *Water pollution effects, Algal blooms, Benthos, Bream, Crustaceans, Cyanophyta, Eutrophic lakes, Eutrophication, Fish, Fish populations, Midges, Phosphorus, Pike, Plankton, Protozoa, Rotifers, Species diversity, Walleyes, Water pollution.

The Zemborzyce Reservoir was formed in 1974 by damming the Bystrzyca River in the southern districts of Lublin, Eastern Poland. It fulfills three basic functions: (a) water level regulation of the Bystrzyca River, (b) recreation, and (c) fishing and angling. The Zemborzyce Reservoir also accumulates a high load of municipal sewage and industrial wastes carried in the middle part of the river and its tributaries. The reservoir plays a purification role. The waters of the Bystrzyca River bring in huge amounts of suspended matter and phosphorus; these are gradually making the reservoir shallow and eutrophic. The symptoms of this process are frequent algae blooms (especially blue-green algae) in summer. The fauna of the reservoir is low in diversity and is characteristic of fertile waters. Eutrophobionts (species preferring eutrophic reservoirs) predominate in both plankton and benthos. Numerous colonies of sessile Protozoa cover rotifers, planktonic Crustacea and Chironomidae larvae. The bream is most abundant and the pike, which was a leading predator at the beginning, now has been replaced by pike-perch. (Mertz-PTT)
W90-07763

DRIFT OF AQUATIC INSECTS FOLLOWING METHOXYCHLOR TREATMENT OF THE SASKACHEWAN RIVER SYSTEM.
Saskatchewan Univ., Saskatoon. Dept. of Biology.
L. M. Dosdall, and D. M. Leumkuhl.
Canadian Entomologist CAENAF, Vol. 121, No. 12, p 1077-1096, December 1989. 11 fig, 4 tab, 30 ref.

Descriptors: *Aquatic drift, *Aquatic insects, *Methoxychlor, *Saskatchewan River, *Species diversity, *Water pollution effects, Biological studies, Canada, Downstream, Ecological effects, Insecticides, Toxicity.

Drift of aquatic insects was compared at three sites downstream (21, 38, and 107 km) from methoxychlor (0.3 mg/L for 15 min.), a larvicide used to control black fly populations, treatment of the North Saskatchewan River, relative to an upstream untreated site. Species of Diptera (Simuliidae), Ephemeroptera, Plecoptera, Trichoptera, and Hemiptera were studied. Drift responses differed depending on species, distance from the injection site, and time after methoxychlor injection. Exposure to methoxychlor initiated catastrophic drift of aquatic insects at all downstream sites. Of 22 species compared before treatment and following methoxychlor injection, post-treatment drift of 17, 21, and 13 species significantly exceeded pre-treatment drift at the 21, 38, and 107 km sites. Methoxychlor treatment initiated or increased drift of several normally non-drifting species. Similar drift patterns were observed among closely related taxa during the catastrophic phase. For all species studied, comparisons of 24-hour drift densities between days preceding and following the catastrophic phase of treatment indicated significant post-treatment drift density increases or decreases at one or more of the downstream sites, but not at the untreated site. Species were classified according to their drift responses to methoxychlor treatment. Different drift responses may have been caused by functional feeding group, microhabitat, body size, and morphological characteristics of species. (Author's abstract)
W90-07820

DETERMINING CHEMICAL TOXICITY TO AQUATIC SPECIES: THE USE OF QSARS AND SURROGATE SPECIES.
D. J. W. Blum, and R. E. Speece.
Environmental Science and Technology ESTHAG, Vol. 24, No. 3, p 284-293, March 1990. 5 fig, 1 tab, 35 ref. NSF Grant ECE-86-17101.

Descriptors: *Aquatic bacteria, *Bioindicators, *Fathead minnows, *Water pollution effects, Correlation analysis, Toxicity.

Quantitative structure-activity relationships (QSARs) and surrogate organisms used in interspecies correlations have great potential as methods for helping to fill the need for toxicity data. Depending on the accuracy required, predictions from these correlations can serve as estimates of toxicity, first guesses of toxicity to help guide further testing, or checks on existing data to help identify experimental errors. QSARs and interspecies correlations were developed for a wide variety of chemical pollutants that act by nonreactive toxicity mechanisms for aerobic heterotroph bacteria, Nitrosomonas, methanogens, fathead minnows, and the Microtox test. The QSAR methods used log P, linear solvation energy relationships (LSER), and molecular connectivity, and were all successful in correlating toxicity. The LSER methods were most accurate and covered the greatest range of chemicals. Parameters were more readily available to apply log P and molecular connectivity QSARs. Molecular connectivity indices could be computed simply from structural formulas with no knowledge of chemical properties. Log P and LSER QSARs afforded a more intuitive understanding of the properties affecting toxicity. The toxicity of chemicals to some bacteria can be used to estimate the toxicity to other bacteria and to fish using interspecies correlations and comparisons. The correlations between bacteria and fish are valuable, as are the correlations involving Microtox, due to the relative simplicity of obtaining bacteria (particularly Microtox) data. Further research in several areas will enhance the development of high-quality correlations. Reactive toxicants must be identified and studied to better define the range of applicability for nonreactive toxicity correlations and to assess the potential for inclusion of reactive toxicants in interspecies correlations. The effects of combining toxicants need to be researched. Continued development of standard toxicity testing methods will provide data for future enlarged QSARs and interspecies correlations. The development of the very promising QSAR techniques, particularly linear solvation energy relationships, and molecular connectivity will aid the use of these methods in toxicity work. (Geiger-PTT)
W90-07882

OHIO RIVER OIL SPILL: A CASE STUDY.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5B.
W90-07893

IMPACTS OF LOG STORAGE UPON EPILIMNETIC DISSOLVED OXYGEN AND JUVENILE SOCKEYE SALMON IN BABINE LAKE, BRITISH COLUMBIA.
British Columbia Univ., Vancouver. Westwater Research Centre.
D. A. Levy, I. Yesaki, and B. Christensen.
Water Research WATRAG, Vol. 24, No. 3, p 337-343, March 1990. 4 fig, 19 ref.

Descriptors: *Lake fisheries, *Limnology, *Logging, *Salmon, *Water pollution effects, Deoxygenation, Fish populations, Log storage, Sockeye salmon, Temperature.

Limnological conditions and habitat use by juvenile sockeye salmon were monitored both prior and subsequent to the development of a log transportation system in Babine Lake. Hypoxic conditions developed in the epilimnion as water temperatures increased following the spring thaw in 1985. Deoxygenation was attributed to respiration by bacteria which formed a gelatinous slime layer on the underside of submerged logs. The observed decrease in juvenile sockeye salmon numbers in affected areas of the log dump site appeared to be a response to epilimnetic hypoxia. (Author's abstract)
W90-07916

SHORT-TERM TOXICITY TEST USING ESCHERICHIA COLI: MONITORING CO2 PRODUCTION BY FLOW INJECTION ANALYSIS.
Universidade Estadual de Campinas (Brazil). Inst. de Quimica.
For primary bibliographic entry see Field 5A.
W90-07918

APPLICATION OF THE COMMUNITY DEGRADATION INDEX TO SOUTH AFRICAN ESTUARIES.
National Inst. for Water Research, Congella (South Africa). Natal Regional Lab.
A. E. L. Ramm.
Water Research WATRAG, Vol. 24, No. 3, p 383-389, March 1990. 3 fig, 1 tab, 12 ref.

Descriptors: *Estuaries, *Fish populations, *Species diversity, *Water pollution effects, Degradation index, Evaluation techniques, South Africa, Water resources management.

A community degradation index (CDI) has been recently developed which utilized the information contained in the fish assemblages from several North American river basins to describe their relative degree of degradation. This approach has been applied to describe the relative degradation of 62 estuarine and lagoonal systems situated on the Natal coast in South Africa. The 62 systems were first classified into six major groupings based upon eight physical-hydrologic parameters. This classification procedure involved the use of detrended correspondence analysis, two-way classification techniques and principle components analysis. Reference faunal lists were then developed for each of the physical groupings using historical data and by obtaining the consensus of local experts. CDI values were calculated for each system by comparing its reference faunal list with species lists resulting from biological surveys conducted between 1981-1986. Computed values ranged from 0.2 (undegraded) to 8.2 (severely degraded). The most degraded system was one which, through excessive siltation, no longer exchanges water with the sea and has largely lost its estuarine functions. Several interesting examples are presented of the application of the index to planning concerns in Natal Province. (Author's abstract)
W90-07924

POLLUTION FROM FISH FARMS.
For primary bibliographic entry see Field 5B.
W90-07928

CHANGES IN HARD BOTTOM COMMUNITIES RELATED TO BOAT MOORING AND TRIBUTYLTIN IN SAN DIEGO BAY: A NATURAL EXPERIMENT.
Moss Landing Marine Labs., CA.
H. S. Lenihan, J. S. Oliver, and M. A. Stephenson.
Marine Ecology Progress Series MESEDT, Vol. 60, No. 1/2, p 147-159, February 1990. 6 fig, 7 tab, 48 ref.

Descriptors: *Antifoulants, *Benthic fauna, *Boating, *Estuarine environment, *Organotin compounds, *San Diego Bay, *Water pollution effects, Aquatic habitats, Boat moorings, Embayments, Species composition.

San Diego Bay contains a number of harbors and other similar-sized embayments. Some contain many boats and others relatively few, providing a unique natural experiment where the ecological impact of mooring many boats was evaluated. Back-bay areas with many boats contained depauperate hard-bottom or fouling communities (less cover, biomass, and fewer species) compared with similar areas in embayments with few boats. Embayments with many boats were characterized by serpulid polychaete worms, filamentous algae, and a solitary tunicate, Ciona intestinalis. These groups apparently tolerated the physical and chemical stresses associated with many boats, but were replaced by other sessile invertebrates, such as mussels, sponges, bryozoans, and other tunicates, in embayments with few boats. These groups are more characteristic of hard bottom communities on many natural reefs. Unlike the sessile organisms,

the motile crustaceans and polychaetes that nestled among the sessile groups were strongly associated with microhabitats, rather than the presence of many or few boats. However, there were more species of nestling invertebrates in embayments with few boats. In comparing embayments with many and few boats, sampling was confined to back-bay areas. Hard bottom communities at the front of embayments were similar to back-bay areas where there were few boats. The concentration of tributyltin was also higher in embayments with many boats. It is hypothesized that tributyltin is a cause of the changes in hard bottom communities. Hydrographic variations among embayments with many and few harbors could not explain the consistent community patterns. (Author's abstract)
W90-07942

RADIOACTIVE HAZARD OF POTABLE WATER IN VIRGINIA AND MARYLAND.
George Mason Univ., Fairfax, VA. Center of Basic and Applied Science.
D. G. Mose, G. W. Mushrush, and C. Chrosniak.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 508-513, April 1990. 3 tab, 10 ref.

Descriptors: *Drinking water, *Epidemiology, *Groundwater pollution, *Radon radioisotopes, *Water pollution effects, Cancer, On-site tests, Potable water, Public health, Surveys, Well water.

Only a few studies have examined instances of prolonged exposure to radionuclide concentrations found in natural settings. Starting in the winter of 1986-87, a study of indoor radon and soil radon was conducted, which included approximately 1400 people, over 1000 of whom have consumed their present water supply for 5 or more years, and over 700 of whom have consumed this water for 10 or more years. Homeowners filled out a survey about their family health, including age of each home occupant, the length of time the person lived in the home, and a few questions about cancer. Homeowners also received a test kit containing an inexpensive syringe, a capped vial with 5 mL of toluene-based liquid scintillation fluid, along with directions on how to collect 10 mL of drinking water from a commonly used water tap. The study found that there is a measurable increase in the rate of cancer with increasing water radon, and this rate increases as the exposure interval to the present water supply increases. The incidence of cancer is about twice as great for the well water group, compared to people who obtain municipal water. People who consume water from a private well with < 2500 pCi/L of dissolved radon have an incidence of cancer similar to people who consume city water, but both groups have a lower incidence than the people who consume water from a private well with more than 2500 pCi/L of dissolved radon. For people who have consumed their present water supply for 10 or more years, the city water population has the lowest incidence of cancer and the well water population has a cancer incidence that is about twice as high. The ingestion of radon enriched water appears to be a health concern, because radon, and its associated radionuclides can move throughout the body to produce an effect at many cancer-prone sites. Since well water almost always carries some radon, public health officials should be concerned about radon in both air and water. (Brunone-PTT)
W90-08018

PERFORMANCE OF A NEW ECOTOXICOLOGICAL INDEX TO ASSESS ENVIRONMENTAL IMPACTS ON FRESHWATER COMMUNITIES.
Instituto Nacional de Investigaciones Agrarias, Madrid (Spain). Centro de Investigacion y Tecnologia.
J. A. Camargo.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 529-534, April 1990. 1 fig, 2 tab, 12 ref.

Descriptors: *Data interpretation, *Ecological effects, *Ecotoxicology, *Toxicology, *Water pollution effects, Benthic environment, Biological stud-

Group 5C—Effects Of Pollution

ies, Diversity index, Ecosystems, Macroinvertebrates, Mathematical equations, Population density, Sample preparation, Species diversity.

If an aquatic organism is not adapted to thrive in an environmental disturbance, its ability to grow, reproduce, or compete in the biological community will be affected negatively, being substituted for another one more resistant and better adapted to environmental stress. The performance of a simple ecotoxicological index to assess environmental impacts produced by man's activities on freshwater communities was derived by totaling the species deficit index and a new species substitution index. The first index measures the percentage difference between the number of species occurring above and below the disturbance point. The second index measures the species substitution percentage between both places. A sample of the benthic riffle macroinvertebrate community was taken at each of five sampling stations using a cylinder sampler. All samples were preserved in Formalin until their separation, determination, and counting. The following biological parameters and indices were calculated: the number of species or species richness, the organism density, the number of common species, the Margalef's diversity index, the Shannon's diversity index, the species substitution index, and the ecotoxicological index. The highest value of the ecotoxicological index corresponded with the smallest diversity because effects of dam and industrial effluent act simultaneously on the benthic macroinvertebrate community at the third sampling station. However, the rank of environmental impact decreased with the distance to disturbance points. The taxonomic identification of species is perhaps the only and major problem in using this index. (Brunone-PTT)
W90-08020

HEPATIC ENZYME ACTIVITY AFTER COMBINED ADMINISTRATION OF METHYLMERCURY, LEAD AND CADMIUM IN THE PEKIN DUCK.
Ontario Veterinary Coll., Guelph. Dept. of Biomedical Sciences.
S. A. Jordan, and M. K. Bhatnagar.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 623-628, April 1990. 3 tab, 20 ref.

Descriptors: *Cadmium, *Ducks, *Enzymes, *Heavy metals, *Lead, *Mercury, *Water pollution effects, Animal physiology, Aquatic environment, Biochemistry, Biotransformation, Chemical interactions, Liver, Toxicity.

In order to adequately assess the environmental impact of heavy metals, it is important to consider that they may occur simultaneously in the environment, where they may interact to alter their individual toxicities on living systems. Metals such as mercury, lead and cadmium can be found in all levels of the polluted ecosystem, and in animals inhabiting such areas. A major toxic manifestation of heavy metal exposure is the perturbation of a wide range of enzyme systems in virtually all subcellular compartments. Ducks were exposed to combinations of methylmercury, lead, and cadmium to study the effects in vivo of heavy metals on acid phosphatase (AP), glutathione S-transferase (GST), and cytochrome c oxidase (cyt c ox) in the liver. AP levels were significantly lowered (P < 0.05) in all treatment groups receiving cadmium, as compared to the control, except for a group receiving cadmium and lead concurrently. Levels of GST were significantly depressed only in the cadmium alone group, when compared with controls. Combined administration of methylmercury and/or lead with cadmium may affect cadmium's action on GST since the activity of GST was not significantly different from control levels in these combined groups. Since GST is an important enzyme in the phase II biotransformation system, any interference in its activity by heavy metals such as cadmium may predispose the tissue to toxic effects of other environmental contaminants. No significant differences in the activity of cyt c ox in the liver of the ducks were observed between the control group and individual treatment groups. However the mercury interaction effect was significant, indicating that, overall, groups administered

mercury had significantly lower activity that groups not given mercury. (Brunone-PTT)
W90-08024

EFFECT OF CHEMICALLY CONTAMINATED MARINE SEDIMENT ON NAUPLIAR PRODUCTION OF THE MARINE HARPACTICOID COPEPOD, TIGRIOPUS CALIFORNICUS.
National Marine Fisheries Service, Seattle, WA. Northwest Fisheries Center.
D. A. Misitano, and M. H. Schiewe.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 636-642, April 1990. 1 fig, 2 tab, 17 ref.

Descriptors: *Copepods, *Larvae, *Marine sediments, *Sediment contamination, *Water pollution effects, Animal physiology, Bioassay, Bioindicators.

There is a growing body of evidence indicating that chemically contaminated sediments in urban bays and estuaries pose a significant threat to the productivity of these marine habitats. Particularly at risk are benthic species which live in direct contact with the sediment. However, nondemersal species are also at risk via the food chain and by direct contact with resuspended sediment particulates. The harpacticoid copepod, Tigriopus californicus, was exposed to sediments from urban and nonurban bays, and reproductive success was evaluated. Naupliar production was irregular in the treatments exposed to test sediments. Exposure to chemically contaminated marine sediments caused copepod reproductive patterns to change, delayed the time of peak production, and reduced the overall number of nauplii produced. Based on these findings, this species appears to be a good candidate for use as a test organism in a chronic effects sediment bioassay. (Brunone-PTT)
W90-08026

PROFILE OF METAL-BINDING PROTEINS AND HEME OXYGENASE IN RED CARP TREATED WITH HEAVY METALS, PESTICIDES AND SURFACTANTS.
Nagasaki Univ. (Japan). Faculty of Pharmaceutical Sciences.
For primary bibliographic entry see Field 5B.
W90-08027

ACUTE LETHAL TOXICITY OF AMMONIA AND SUSPENDED SEDIMENT MIXTURES TO CHINOOK SALMON (ONCORHYNCHUS TSHAWYTSCHA).
Department of Fisheries and Oceans, Cultus Lake (British Columbia). Cultus Lake Salmon Research Lab.
J. A. Servizi, and R. W. Gordon.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 650-656, April 1990. 2 fig, 19 ref.

Descriptors: *Ammonia, *Salmon, *Suspended sediments, *Toxicity, *Trout, *Water pollution effects, Fraser River, Lethal limit, Mortality, River sediments, Sediment contamination, Temperature.

Ammonia poses a potential hazard to aquatic life in the vicinity of many municipal and industrial discharges. Criteria were established for ammonia to protect aquatic life and were revised to take account of the lower tolerance of salmon and trout and the influence of hydrogen ion concentration and temperature. Suspended sediments can be directly lethal to salmonids and have been shown to cause sub-lethal histopathological, physiological, and behavioral responses. The acute lethal toxicities of mixtures of Fraser River sediments and ammonia to juvenile chinook salmon (Oncorhynchus tshawytscha) were studied. The 96 hour LC50 for juvenile chinook salmon exposed to ammonia at 7 C was 0.45 mg/L un-ionized ammonia. For rainbow trout, the mean 96 hour LC50 was 0.61 mg/L un-ionized ammonia. The 96 hour LC50 for juvenile chinook salmon exposed to suspended sediment was 31 g/L at 7.0 C. Buccal cavities of dead fish were filled with sediment but none was observed in the digestive cavity beyond this point. The 96 hour toxicities of ammonia-suspended sedi-

ment mixtures increase with increasing content of these two constituents. A toxic unit model, separating toxicity results into acute toxicity zones provides a broad application of toxicity data. LC50 data can be estimated for fish species and sediments other than juvenile chinook and Fraser river suspended sediment. Assuming the mechanisms of toxicity for ammonia and suspended sediments are similar for juvenile chinook and other salmonids, toxicity could be estimated. (Brunone-PTT)
W90-08028

OUTBREAK OF WATERBORNE CRYPTOSPORIDIOSIS CAUSED BY POST-TREATMENT CONTAMINATION.
Scottish Parasite Diagnostic Lab., Glasgow. Dept. of Bacteriology.
For primary bibliographic entry see Field 5B.
W90-08029

EXAMINATION OF THE IMPACT OF RADIOACTIVE LIQUID EFFLUENT RELEASES FROM THE RANCHO SECO NUCLEAR POWER PLANT.
Oak Ridge National Lab., TN. Health and Safety Research Div.
For primary bibliographic entry see Field 5B.
W90-08032

WATERBORNE DISEASE OUTBREAKS, 1986-1988.
W. C. Levine, and G. F. Craun.
MMWR: Morbidity and Mortality Weekly Report, Vol. 39, No. SS1, p 1-13, March 1990. 1 fig, 8 tab, 38 ref.

Descriptors: *Drinking water, *Path of pollutants, *Pathogenic bacteria, *Public health, *Water pollution effects, *Water pollution sources, Epidemiology, Fecal coliforms, Giardiasis, Human diseases, Protozoa, Recreation, Shigellosis, Viruses.

From 1986 to 1988, 24 states and Puerto Rico reported 50 outbreaks of illness due to potable water, affecting 25,846 persons. The protozoal parasite Giardia lamblia was the agent most commonly implicated in outbreaks, as it has been for the last 10 years; many of these outbreaks were associated with ingestion of chlorinated but unfiltered surface water. Shigella sonnei was the most commonly implicated bacterial pathogen; in outbreaks caused by this pathogen, water supplies were found to be contaminated with human waste. Cryptosporidium contamination of a chlorinated, filtered public water supply caused the largest outbreak during this period, affecting an estimated 13,000 persons. A large multistate outbreak caused illness with Norwalk-like virus among an estimated 5000 persons. The first reported outbreak of chronic diarrhea of unknown cause associated with drinking untreated well water occurred in 1987. Twenty-six outbreaks due to recreational water use were also reported, including outbreaks of Pseudomonas dermatitis associated with the use of hot tubs or whirlpools, and swimming-associated shigellosis, giardiasis, and viral illness. Although the total number of reported water-related outbreaks has been declining in recent years, the few large outbreaks due to Cryptosporidium, Norwalk-like virus, Shigella sonnei, and Giardia lamblia caused more cases of illness in 1987 than have been reported to the Water-Related Disease Outbreak Surveillance System for any year since the Center for Disease Control and the Environmental Protection Agency began tabulating these data in 1971. (Author's abstract)
W90-08034

NEUROTOXIC BEHAVIORAL EFFECTS OF LAKE ONTARIO SALMON DIETS IN RATS.
State Univ. of New York Coll. at Oswego. Dept. of Psychology.
D. R. Hertzler.
Neurotoxicology and Teratology NETEEC, Vol. 12, No. 2, p 139-143, March/April 1990. 4 fig, 2 tab, 27 ref.

Descriptors: *Path of pollutants, *Salmon, *Water pollution effects, Animal behavior, Bioaccumulation, Laboratory animals, Mirex, Polychlorinated biphenyls.

Six experiments were conducted to examine possible effects from exposure to contaminants in Lake Ontario salmon, administered to rats through their diets. Rats were fed different concentrations of fish (8%, 15%, or 30%) in one of three diet conditions: Lake Ontario salmon, Pacific Ocean salmon, or laboratory rat chow only. Following 20 days on the diets, rats were tested for 5 minutes per day in a modified open field for one or three days. Lake Ontario salmon consistently produced significantly lower activity, rearing, and nosepoke behaviors, in comparison with ocean salmon or rat chow diet conditions. A dose-response effect for concentration of lake salmon was obtained, and the attenuation effect occurred in males, females, adult or young animals, and postweaning females, with fish sampled over a five-year period. While only two of several potential contaminants were tested, both fish and brain analyses of mirex and PCBs relate to the behavioral effects. (Author's abstract)
W90-08035

TROPHIC STATUS AND THE PELAGIC SYSTEM IN LAGO MAGGIORE.
Istituto Italiano di Idrobiologia, Pallanza (Italy).
R. de Bernardi, G. Giussani, M. Manca, and D. Ruggiu.
Hydrobiologia HYDRB8, Vol. 191, p 1-8, February 28, 1990. 6 fig, 3 tab, 10 ref.

Descriptors: *Eutrophication, *Italy, *Limnology, *Water pollution effects, Biomass, Chlorophyll a, Chlorophyta, Crustacea, Fish, Lake Maggiore, Long-term studies, Model studies, Nitrates, Pelagic zone, Phosphorus removal, Trophic level.

Long-term data were obtained on the limnological parameters of Lago Maggiore (Northern Italy). The results permitted a better definition of the conditions of lake eutrophication and recovery and demonstrated the resilience in the lake's biota. The data covered here cover the period 1960 through 1988 and include phosphorus concentrations, nitrate-N, primary production, chlorophyll a, total phytoplankton biomass (cell volume), blue-green algae biomass, biomass of cladocera and copepods, and fish yield. Two distinct periods are apparent in the data: (1) a period of rapid eutrophication (early 1960s to late 1970s) and (2) a period of moderate oligotrophication (early 1980s to the present). During the eutrophication phase the trophic status of the lake showed excellent agreement with the Vollenweider-OECD model. Predictions made from the model that a 50% reduction in phosphorus should have provoked a strong decline in trophic status in the lake from meso-eutrophy to oligotrophy were not confirmed by the data of the past 8 yr. Although phosphorus was cut in half, standing stocks of the biota did not decline as expected. (Rochester-PTT)
W90-08065

SOME CHARACTERISTICS OF THE COMMUNITY OF AUTOTROPHS OF LAKE SEVAN IN CONNECTION WITH ITS EUTROPHICATION.
Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station.
A. S. Paparov.
Hydrobiologia HYDRB8, Vol. 191, p 15-21, February 28, 1990. 4 fig, 1 tab, 16 ref.

Descriptors: *Eutrophication, *Lake Sevan, *Soviet Union, *Water pollution effects, Armenia, Nutrients, Photosynthesis, Plankton, Primary productivity.

Eutrophication of Lake Sevan (Caucasus Mountains, western Armenia) caused by the artificial lowering of water level was accompanied by changes in the structure and dynamics of the planktonic communities. A dominance of diatoms up to 1983 was changed that of green algae in recent years. Primary production of the plankton rose and then decreased during the process of eutrophication. The annual average primary production in 1982-1986 (250 g C/sq m/yr) evidently

was close to the steady-state production under the present morphometry of the lake. The activity coefficient of phytoplanktonic photosynthesis changed within relatively narrow limits despite significant changes in the concentrations of major nutrients and in the community structure and productivity of the phytoplankton. (Author's abstract)
W90-08067

ASPECTS OF THE ECOLOGY OF A FILAMENTOUS ALGA IN A EUTROPHIED LAKE.
Warsaw Univ. (Poland). Dept. of Hydrobiology.
T. Ozimek.
Hydrobiologia HYDRB8, Vol. 191, p 23-27, February 28, 1990. 2 fig, 4 tab, 13 ref.

Descriptors: *Algae, *Lake Mikolajskie, *Poland, *Water pollution effects, Autecology, Biomass, Eutrophic lakes, Growth, Life history studies, Nitrogen, Phosphorus, Photosynthesis.

In the eutrophic Lake Mikolajskie (North Poland), macrophytes disappearing from the deeper parts of the littoral are replaced by Vaucheria dichotoma Ag. This forms a belt at 3.0-4.5 m to which depth only 1% of surface light penetrates. The zone of V. dichotoma has a layered structure. Some filaments are covered with mud and receive no light, but are alive and photosynthesize when transferred to light. V. dichotoma prefers fertile environments with a high content of phosphate-phosphorus and ammonium-nitrogen. The alga is evergreen and its biomass changes relatively little during a year. (Author's abstract)
W90-08068

RELATION OF BIOTIC AND ABIOTIC INTERACTIONS TO EUTROPHICATION IN TJEUKEMEER, THE NETHERLANDS.
Limnologisch Inst., Oosterzee (Netherlands).
E. H. R. R. Lammens.
Hydrobiologia HYDRB8, Vol. 191, p 29-37, February 28, 1990. 5 fig, 3 tab, 32 ref.

Descriptors: *Eutrophication, *The Netherlands, *Tjeukemeer, *Water pollution effects, Chlorophyll a, Daphnia, Fish, Gill nets, Lake IJsselmeer, Monitoring, Oscillatoria, Phosphorus, Predators, Water temperature.

During the summer months of 1974-1985, chlorophyll a and total P concentrations, biomass of Daphnia hyalina, smelt (Osmerus eperlanus), bream (Abramis brama), and pikeperch (Stizostedion lucioperca), water temperature, and water intake from Lake IJsselmeer were monitored in Tjeukemeer (The Netherlands), a shallow, hypertrophic lake with high turbidity. During this period the bream and pikeperch stocks were manipulated as result of the termination of the gill-net fishery in 1977; larval smelt immigrated each year from the large Lake IJsselmeer and contributed greatly to the yearly smelt recruitment. The correlation matrix of the nine studied variables showed a positive correlation between bream and chlorophyll a, but a negative one between smelt and chlorophyll a. This explained by considering smelt the dependent variable. In a multi-linear regression there was a negative effect of temperature, chlorophyll a, and pikeperch on smelt and the water intake of Lake IJsselmeer. The positive relation of Daphnia hyalina and chlorophyll a probably was related to better survival chances of D hyalina in an Oscillatoria-rich environment when smelt is the most important predator. An increasing biomass of bream coincided with higher total P levels and probably contributed to higher chlorophyll a levels. (Author's abstract)
W90-08069

CHANGES IN THE FISH AND ZOOPLANKTON COMMUNITIES OF RINGSJON, A SWEDISH LAKE UNDERGOING MAN-MADE EUTROPHICATION.
Institute of Freshwater Research, Drottningholm (Sweden).
E. Bergstrand.
Hydrobiologia HYDRB8, Vol. 191, p 57-66, February 28, 1990. 11 fig, 5 tab, 23 ref.

Descriptors: *Agricultural runoff, *Eutrophication, *Lake Ringsjon, *Sweden, *Water pollution effects, Bosmina, Competition, Daphnia, Diaptomus, Fish, Nutrients, Predation, Roach, Zooplankton.

During the 20th century Lake Ringsjon (Sweden) has developed from a mesotrophic to a eutrophic lake, and the phytoplankton community has changed from a rather diverse community to a monoculture of blue-green algae. The eutrophication process has accelerated during the last decade. The most important external nutrient loading today comes from agriculture. The fish fauna of Lake Ringsjon is dominated by cyprinids, especially roach, and there are relatively few predatory fish. During the seventies the mean size of roach decreased, and measurements of the zooplankton community indicated that the predation pressure on zooplankton had increased. The mean sizes of cladocerans such as Daphnia and Bosmina, which were selected for by planktivorous fish, decreased. The size of the calanoid Diaptomus, which was not preyed upon by the dominating fish species, did not change. The growth of zooplankton-feeding stages of several fish species was retarded, meaning that growth of young perch decreased, whereas the older roach mainly were affected. In the present circumstances, planktivorous roach can maintain a large population of small individuals, whereas the predatory perch is at a disadvantage and predation on zooplankton is intense. (Author's abstract)
W90-08072

PHOSPHORUS EUTROPHICATION RESEARCH IN THE LAKE DISTRICT OF SOUTH WESTERN FRIESLAND, THE NETHERLANDS: PRELIMINARY RESULTS OF ABIOTIC STUDIES.
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
H. J. W. J. Van Huet.
Hydrobiologia HYDRB8, Vol. 191, p 75-85, February 28, 1990. 6 fig, 10 ref.

Descriptors: *Eutrophic lakes, *Eutrophication, *The Netherlands, *Water pollution effects, Chemical reactions, Chlorides, Decision making, Hydrology, Management planning, Model studies, Monitoring, Phosphorus, Seasonal distribution, Slotermeer, Tjeukemeer.

The water quality of the lakes in southwestern Friesland (The Netherlands) is influenced by a rather complex hydrology. A study, begun in 1984, focused on phosphorus, modeling the hydrology and phosphorus dynamics to compare scenarios for policy and management. Although there currently are no complete water and phosphorus balances and thus no modeling results, some conclusions can be drawn. The water of the studied area is eutrophic, with total P concentrations in summer above 0.15 mg/L. Hydrology plays an important role, particularly in the water quality of Tjeukemeer. Slotermeer appeared to be relatively isolated. Hydrology during summer can be studied roughly by monitoring chloride concentrations at several locations. In 1985 it was estimated that about 90% of the inflowing water into Tjeukemeer originated from polders. Generally the total P concentrations of polder water are higher than those of IJsselmeer water. Total P contents in sediments varied from 0.1 to 4.0 mg/g of dry weight. Most P was Fe-bound and Al-bound. There was a slight tendency for decreasing P content with increasing sediment depth. Phosphorus release experiments with winter sediments showed that P release was less than 1 mg P/sq m/day. Probably the process was influenced by mineralization. (Rochester-PTT)
W90-08073

PHOSPHORUS DYNAMICS FOLLOWING RESTORATION MEASURES IN THE LOOSDRECHT LAKES (THE NETHERLANDS).
Limnologisch Inst., Nieuwersluis (Netherlands).
For primary bibliographic entry see Field 5G.
W90-08074

Group 5C—Effects Of Pollution

INFLUENCE ON PHYTOPLANKTON BIO-MASS IN LAKES OF DIFFERENT TROPHY BY PHOSPHORUS IN LAKE WATER AND ITS REGENERATION BY ZOOPLANKTON.
Polish Academy of Sciences, Mikolajki. Hydrobiological Research Station.
J. Ejsmont-Karabin, and I. Spodniewska.
Hydrobiologia HYDRB8, Vol. 191, p 123-128, February 28, 1990. 2 fig, 1 tab, 18 ref.

Descriptors: *Biomass, *Eutrophication, *Limnology, *Model studies, *Path of pollutants, *Phosphorus, *Poland, *Trophic level, *Water pollution effects, Cyanophyta, Cycling nutrients, Mathematical equations, Phytoplankton, Zooplankton.

In 49 unpolluted lakes of northeastern Poland, the biomass of algae in summer is related significantly to the concentration of total P and to the rate of P regeneration by the zooplankton. Using a model with equations describing these relationships, the biomass of blue-green algae and other phytoplankton groups was predicted for 14 unpolluted lakes. A good approximation of actual values was obtained only for the biomass of blue-green algae calculated from the estimated rate of P regeneration by zooplankton. It is hypothesized that more-or-less edible algae of other classes did not show dependence on the rate of input of regenerated P because their biomass was heavily reduced by grazing of the zooplankton. (Author's abstract)
W90-08078

PHYTOPLANKTON AND ZOOPLANKTON (CLADOCERA, COPEPODA) RELATIONSHIP IN THE EUTROPHICATED RIVER DANUBE (DANUBIALIA HUNGARICA, CXI).
Magyar Tudomanyos Akademia, Budapest. Station for Danube Research.
A. Bothar, and K. T. Kiss.
Hydrobiologia HYDRB8, Vol. 191, p 165-171, February 28, 1990. 5 fig, 2 tab, 32 ref.

Descriptors: *Danube River, *Eutrophication, *Hungary, *Water pollution effects, Biomass, Chlorophyta, Crustacea, Diatoms, Ecosystems, Phytoplankton, Primary productivity, Seasonal distribution, Zooplankton.

The seasonal variation in primary production, numbers of individuals, and biomass of phytoplankton and zooplankton was studied in the Danube River in 1981. The secondary production of two dominant zooplankton species (Bosmina longirostris and Acanthocyclops robustus) also was estimated. In the growing season (April-September), numbers of individuals, dry weight, and chlorophyll a contents of phytoplankton ranged from 30-90 thousand individuals/L, 3-12 mg/L, and 50-170 microgram/L, respectively. Species of Thalassiosiraceae (Bacillariophyta) dominated in the phytoplankton, with a subdominance of Chlorococcales in summer. Individual numbers and dry weights of crustacean zooplankton ranged between 1400 and 6500 individuals per cubic meter, and 1.2-12 mg/sq m, respectively. The daily mean gross primary production was 970 mg C/cu m/day and the net production was 660 mg C/cu m/day. Acanthocyclops robustus populations produced 0.2 mg C/cu m/day as an average, whereas Bosmina longirostris populations produced 0.07 mg C/cu m/day. The 'ecological efficiency' between phytoplankton and crustacean zooplankton was 0.03%. (Author's abstract)
W90-08082

SURFACE WATER ACIDIFICATION PROJECT (SWAP) PALEOLIMNOLOGY PROGRAMME.
University Coll., London (England). Palaeoecology Research Unit.
R. W. Batterbee, and I. Renberg.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 227-232, March 12, 1990. 2 fig, 1 tab, 1 ref.

Descriptors: *Acid rain, *Air pollution effects, *Dating, *Lake acidification, *Lake sediments, *Paleolimnology, *Surface Water Acidification Project, Chironomids, Cladocerans, Diatoms, Error estimation, Hydrogen ion concentration,

Path of pollutants, Polycyclic aromatic hydrocarbons, Radioactive dating, Sedimentation rates, Sediment accumulation, Sedimentology, Sulfur, Temporal variation, Trace metals.

In the past two decades, paleolimnologists have developed sampling, dating, and analytical approaches that now enable the sediment record to be deciphered with precision and accuracy over timescales of relevance to contemporary environmental problems, taking advantage of the relatively rapid accumulation rate of most recent lake sediments. In the Surface Water Acidification Project (SWAP) Paleolimnology Programme these techniques have been used to trace the history of a range of specially selected study sites and to evaluate alternative causes for lake acidification. Lake sediments contain a record of catchment and atmospheric history and comparisons of these with records of lake history through time and between sites often allow the causes, as well as the timing and rate, of historical changes to be inferred. The biological techniques used include diatom analysis, chrysophyte analysis, chironomid analysis, and cladoceran analysis. New methods of hydrogen ion concentration reconstruction and error estimation have been developed from the data-set. Techniques used to trace atmospheric contamination include trace metal, sulfur, and polycyclic aromatic hydrocarbons (PAH) chemistry. The chronological framework for most studies have been provided by lead-210 dating although carbon-14 wiggle-match dating has also been used. (Brunone-PTT)
W90-08096

RADIOMETRIC DATING OF THE UNITED KINGDOM SWAP SITES.
Liverpool Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
P. G. Appleby, N. Richardson, P.J. Nolan, and F. Oldfield.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 233-238, March 12, 1990. 3 fig, 2 tab, 8 ref.

Descriptors: *Acid rain, *Lake acidification, *Paleolimnology, *Radioactive dating, *Sedimentology, *Surface Water Acidification Project, *United Kingdom, Americium radioisotopes, Cesium radioisotopes, Direct gamma assay, Forest watersheds, Lead radioisotopes, Sediment analysis, Sediment chemistry, Sediment chronology.

Measurements of lead-210 by direct gamma assay have been used to date sediment cores from Surface Water Acidification Project (SWAP) study sites in the UK. By using this isotope, determination of lake sediment dates with a precision of five to ten years is often attainable. Using these techniques, the principal objective within the SWAP programme was to provide a reliable sediment chronology at each site. The results were checked against additional dating evidence from the artificial fallout isotopes cesium-137 and americium-241. At one of the sites, Devoke Water in Cumbria, the cesium-137 and americium-241 data were crucial in identifying a recent sediment hiatus. At sites with recently afforested catchments the sediment record indicated substantial increases in accumulation rates. (Author's abstract)
W90-08097

LEAD-210 CHRONOLOGY OF THE SCANDINAVIAN SWAP SITES.
Uppsala Univ. (Sweden). Dept. of Physics.
F. El-Daoushy.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 239-242, March 12, 1990. 1 fig, 1 tab, 7 ref.

Descriptors: *Acid rain, *Lake acidification, *Lead radioisotopes, *Paleolimnology, *Radioactive dating, *Scandinavia, *Sedimentology, *Surface Water Acidification Project, Atmospheric input, Dissolution, Humic substances, Hydrogen ion concentration, Land use, Sediment chemistry, Spectrometry.

In the Surface Water Acidification Project (SWAP) sediment profiles from five Scandinavian

sites were analyzed for lead-210 by using refined isotope dilution alpha spectrometry. The lead-210 parameters of these lakes were very similar to those obtained for protected forest lakes with no land-use activities. These data demonstrated almost exclusive atmospheric inputs and an internal deposition regulated by the organic fractionation and the grain-size distribution in the sediments. Preliminary speciation experiments showed minor losses of lead-210 through enhanced dissolution of fulvic compounds at acid conditions (hydrogen ion concentration greater than or equal to 4). The sediment accumulation rates (constant rate of unsupported lead-210 supply (CRS) model) of the lakes gradually increased, by at least a factor of three, over the past century although lead-210 parameters did not show any strong signs of enhanced land-use activities. This is perhaps caused by more efficient preservation of the sediments through humic precipitation under more acid conditions. (Author's abstract)
W90-08098

DIATOM COMMUNITIES--THEIR RESPONSE TO CHANGES IN ACIDITY.
Bristol Univ. (England). Dept. of Botany.
F. E. Round.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 243-249, March 12, 1990. 1 fig, 18 ref.

Descriptors: *Acid rain effects, *Diatoms, *Lake acidification, *Limnology, *Population dynamics, *Species composition, Acid rain, Aquatic environment, Calcium, Ecosystems, Hydrogen ion concentration, Path of pollutants, Sample preparation, Seasonal variation, Wales.

The non-planktonic habitats of some Welsh lakes were studied to determine the composition of the diatom component in each, the seasonality of the diatoms, discreteness or otherwise of each community, and the relation of each community to the mean pH of the water of the lakes. Epipelic samples were obtained without contaminants by using appropriate sampling techniques that remove only the live cells, that is, by harvesting live cells off cover glasses placed on sediment surfaces. The lakes samples fell into two discrete groups when the epilithic populations were tabulated: the ones with Eunotia incisa-Tabellaria-flocculata sensu lato dominant and those with Achnanthes minutissima dominant. The distinction is clearly related to hydrogen ion concentration-calcium ion conductivity levels: low in the former, high in the latter. (Brunone-PTT)
W90-08099

ECOPHYSIOLOGY OF EPILITHIC DIATOM COMMUNITIES OF ACID LAKES IN GALLOWAY, SOUTHWEST SCOTLAND.
Hatfield Polytechnic (England). Div. of Environmental and Earth Sciences.
For primary bibliographic entry see Field 2H.
W90-08100

DIATOM QUALITY CONTROL AND DATA HANDLING.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 2H.
W90-08101

DIATOMS AND PH RECONSTRUCTION.
Bergen Univ. (Norway). Botanical Inst.
For primary bibliographic entry see Field 2H.
W90-08102

DISSOLVED ORGANIC CARBON RECONSTRUCTIONS FROM DIATOM ASSEMBLAGES IN PIRLA PROJECT LAKES, NORTH AMERICA.
Queen's Univ., Kingston (Ontario). Dept. of Biology.
For primary bibliographic entry . _ eld 2H.
W90-08103

RECENT ACIDIFICATION AND CHANGES IN THE SUBFOSSIL CHRYSOPHYTE FLORA OF LAKES IN SWEDEN, NORWAY AND SCOTLAND.
Lund Univ. (Sweden). Inst. of Ecology.
For primary bibliographic entry see Field 2H.
W90-08104

MIDGE FAUNA DEVELOPMENT IN ACIDIFIED LAKES IN NORTHERN EUROPE.
National Swedish Environment Protection Board, Solna.
For primary bibliographic entry see Field 2H.
W90-08105

RECENT LAKE ACIDIFICATION AND CLADOCERAN DYNAMICS: SURFACE SEDIMENT AND CORE ANALYSES FROM LAKES IN NORWAY, SCOTLAND AND SWEDEN.
Oslo Univ. (Norway). Biologisk Inst.
For primary bibliographic entry see Field 2H.
W90-08106

SEDIMENT CHEMISTRY AND ATMOSPHERIC CONTAMINATION.
Ulster Univ., Coleraine (Northern Ireland). Limnology Lab.
For primary bibliographic entry see Field 5B.
W90-08107

BRITISH AND SCANDINAVIAN LAKE SEDIMENT RECORDS OF CARBONACEOUS PARTICLES FROM FOSSIL-FUEL COMBUSTION.
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 2H.
W90-08108

LAKE SEDIMENT MAGNETISM AND ATMOSPHERIC DEPOSITION.
Liverpool Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W90-08109

RECORD OF ATMOSPHERIC DEPOSITION ON A RAINWATER-DEPENDENT PEATLAND.
Queen Mary Coll., London (England). School of Biological Sciences.
For primary bibliographic entry see Field 2H.
W90-08110

CAUSES OF LAKE ACIDIFICATION, WITH SPECIAL REFERENCE TO THE ROLE OF ACID DEPOSITION.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 2H.
W90-08111

DEVOKE WATER AND LOCH SIONASCAIG: RECENT ENVIRONMENTAL CHANGES AND THE POST-GLACIAL OVERVIEW.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
For primary bibliographic entry see Field 2H.
W90-08112

12,600 YEAR PERSPECTIVE OF THE ACIDIFICATION OF LILLA ORESJON, SOUTHWEST SWEDEN.
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 5B.
W90-08113

SIGNIFICANCE OF LAND-USE AND LAND-MANAGEMENT CHANGE IN THE ACIDIFICATION OF LAKES IN SCOTLAND AND NORWAY: AN ASSESSMENT UTILIZING DOCUMENTARY SOURCES AND POLLEN ANALYSIS.
University Coll., London (England). Palaeoecology Research Unit.

For primary bibliographic entry see Field 2H.
W90-08114

LAND-USE CHANGE AND LAKE ACIDIFICATION: IRON AGE DE-SETTLEMENT IN NORTHERN SWEDEN AS A PRE-INDUSTRIAL ANALOGUE.
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 2H.
W90-08115

AFFORESTATION AND LAKE ACIDIFICATION: A COMPARISON OF FOUR SITES IN SCOTLAND.
University Coll., London (England). Palaeoecology Research Unit.
A. M. Kreiser, P. G. Appleby, J. Natkanski, B. Rippey, and R. W. Watanabe.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 377-383, March 12, 1990. 3 fig, 1 tab, 10 ref.

Descriptors: *Acid rain effects, *Lake acidification, *Paleolimnology, *Scotland, *Vegetation effects, Acid rain, Afforestation, Air pollution, Diatoms, Forest growth, Forest watersheds, Path of pollutants.

Paleolimnological techniques including diatom analysis were used to examine the acidification and atmospheric contamination histories of four lakes (Loch Chon, Loch Doilet, Loch Tinker, and Lochan Dubh) in Scotland. Results from an afforested and a moorland (control) site in a region of high acid deposition are compared with results from two similar sites in an area receiving lower acid deposition levels. Results show that afforestation of a catchment in the higher acid deposition area has increased the rate of lake acidification. There is no evidence for acidification as a result of forest growth alone in the area of lower acid deposition. (Author's abstract)
W90-08116

PALAEOLIMNOLOGICAL CHANGES RELATED TO ACID DEPOSITION AND LAND-USE IN THE CATCHMENTS OF TWO NORWEGIAN SOFT-WATER LAKES.
National Swedish Environment Protection Board, Solna.
F. Berge, Y. W. Brodin, G. Cronberg, F. El-Daoushy, and H. I. Hoeg.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 385-389, March 12, 1990. 1 fig, 8 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Air pollution effects, *Land use, *Norway, *Paleolimnology, Acid rain, Air pollution, Chironomids, Chrysophyta, Cladocerans, Diatoms, History, Hydrogen ion concentration, Lake acidification, Midges, Nitrogen compounds, Palynology, Particulate matter, Path of pollutants, Pollen analysis, Polycyclic aromatic hydrocarbons, Royrtjorna, Species composition, Sulfur compounds, Trace metals, Verevatn, Waterfleas.

The recent hydrogen ion concentration of two lakes with similar catchments, one (Verevatn) subjected to high and the other (Royrtjorna) to low deposition of sulfur and nitrogen compounds was reconstructed and their histories were compared in relation to acid deposition and land-use. Sediment concentrations of carbonaceous particles, trace metals, polycyclic aromatic hydrocarbons and sulfur were recorded to assess the timing and magnitude of the deposition of airborne pollutants. Pollen analysis and documentary research were employed to study shifts in land-use. Analyses of sedimentary remains of chironomids, cladocerans, chrysophytes, and diatoms were used to document changes in lake acidity and lake history. At the site with low acid deposition, inferred hydrogen ion concentration has oscillated between 5.6 and 5.9 and there is little evidence of atmospheric contamination. At the site with high acid deposition, many centuries of stability are followed by a rapid acidi-

fication from hydrogen ion concentration around 5 in 1900 to the present (1986) level of 4.4. In Verevatn, the sedimentary record indicates a close connection between acid deposition and recent lake acidification. (Brunone-PTT)
W90-08117

RECENT ACIDIFICATION AND BIOLOGICAL CHANGES IN LILLA ORESJON, SOUTHWEST SWEDEN, AND THE RELATION TO ATMOSPHERIC POLLUTION AND LAND-USE HISTORY.
Umea Univ. (Sweden). Dept. of Ecological Botany.
I. Renberg, Y. W. Brodin, G. Cronberg, F. El-Daoushy, and F. Oldfield.
Philosophical Transaction of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 327, No. 1240, p 391-396, March 12, 1990. 1 fig, 14 ref.

Descriptors: *Acid rain, *Air pollution, *Diatoms, *Lake acidification, *Land use, *Paleolimnology, *Sweden, *Water pollution effects, Chironomids, Chrysophyta, Cladocerans, Copper, Ecosystems, Hydrogen ion concentration, Lilla Oresjon, Particulate matter, Path of pollutants, Polycyclic aromatic hydrocarbons, Sediment analysis, Species composition, Sulfur, Water quality trends, Zinc.

Paleolimnological techniques were used to study the recent acidification history of Lilla Oresjon in southwest Sweden, and its relation to the deposition of airborne pollutants and land-use. The sediment analyses suggest that water quality began to deteriorate at the beginning of the twentieth century and resulted in an acute acidification phase in the 1960s. An indifferent (circumneutral) diatom flora with some planktonic taxa was replaced by a non-planktonic acidophilous and acidobiontic flora; diatom inferred hydrogen ion concentrations decreased from 6.1 in the nineteenth century to the present value of about 4.6. The history of acidification and of major biological change is reinforced by the analyses of chrysophyte scales and cladocera and chironomid remains, which show that alterations of species composition and an impoverishment of faunal communities took place. There is close stratigraphic agreement between these biological changes and indicators of the deposition of atmospheric pollutants. The concentration of lead, zinc, copper, and sulfur increased from the beginning of the nineteenth century to peak values during the 1960s and 1970s. Spheroidal carbonaceous particles, polycyclic aromatic hydrocarbons and 'hard' isothermal remanence, indicative of oil and coal combustion, peaked during the 1970s and 1980s, respectively. The increased deposition of airborne pollutants from fossil fuel combustion and industrial processes may be the main cause of the acidification of the lake. (Author's abstract)
W90-08118

RECENT PALAEOLIMNOLOGY OF TWO SITES WITH CONTRASTING ACID-DEPOSITION HISTORIES.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 2H.
W90-08119

ALKALINITY AND PH OF THREE LAKES IN NORTHERN NEW ENGLAND, U.S.A., OVER THE PAST 300 YEARS.
Maine Univ., Orono. Dept. of Botany and Plant Pathology.
For primary bibliographic entry see Field 2H.
W90-08121

LAKE ACIDIFICATION IN FINLAND.
Joensuu Univ. (Finland).
For primary bibliographic entry see Field 2H.
W90-08122

POST-1970 WATER-CHEMISTRY CHANGES AND PALAEOLIMNOLOGY OF SEVERAL ACIDIFIED UPLAND LAKES IN THE U.K.

Group 5C—Effects Of Pollution

University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 2H.
W90-08123

MODELLING LONG-TERM ACIDIFICATION: A COMPARISON WITH DIATOM RECONSTRUCTIONS AND THE IMPLICATIONS FOR REVERSIBILITY.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2H.
W90-08124

PALAEOLIMNOLOGY AND LAKE ACIDIFICATION: A SUMMARY.
Bergen Univ. (Norway). Botanical Inst.
For primary bibliographic entry see Field 2H.
W90-08125

DRINKING WATER AND HEALTH: DISINFECTANTS AND DISINFECTANT BY-PRODUCTS.
National Research Council, Washington, DC. Safe Drinking Water Committee.
Volume 7. National Academy Press, Washington, DC. 1987. 207p.

Descriptors: *Chlorination, *Drinking water, *Water pollution effects, *Water treatment, Aldehydes, Chlorinated hydrocarbons, Chloroform, Ketones, Mutagenicity, Phenols, Public health, Toxicity, Trihalomethanes.

New knowledge about disinfection and disinfectant by-products has led to changes in procedures for disinfecting drinking water in the 6 years since the Safe Drinking Water Committee last reviewed the potential health effects of these practices. The predominant method of drinking water disinfection practiced in the United States today is chlorination. Studies of the toxicity of the by-products of disinfectants have focused on the trihalomethanes (THMs), which are formed during chlorination and for which considerable data on carcinogenicity have been developed. The level of total THMs in finished drinking water, currently regulated at 100 micrograms/L, should be reduced. Noting that chloroform is the principal THM produced by chlorination, the subcommittee found this level to be unsupportable on the basis of the risk values for chloroform developed in this review. Other, nonvolatile by-products of chlorination may be important in contributing mutagenic properties to drinking water, especially when the natural water being treated contains high levels of organic matter. Short-term animal skin tests, although not conclusive, provide indications that organic concentrates from chlorinated water are tumorigenic under some experimental conditions. Unfortunately, many by-products of chlorination and other disinfection practices have not been identified. Consequently, the risks of ingesting cannot be quantified at present, but are potentially high enough to warrant continued efforts to analyze them. The use of alternative methods of drinking water disinfection is increasing, largely due to health and regulatory concerns about trihalomethanes. Thus, the nature and toxicity of the by-products of some other widely used water treatments (chloramination, ozonation, and chlorine dioxide) are also evaluated in the report to the extent allowed by available data. The subcommittee calculated quantitative risk assessment for disinfectants or their by-products where there were sufficient data. These include four distinct components: hazard identification, exposure assessment, dose-response assessment, and characterization of human risk at projected levels and patterns of exposure. By-products examined include: chlorine, chlorine dioxide, chloramines, chlorite, chlorate, trihalomethanes, haloacids, haloaldehydes, haloketones, haloacetonitriles, chloropicrin, and chlorophenols. (Lantz-PTT)
W90-08156

DRINKING WATER AND HEALTH.
National Research Council, Washington, DC. Board on Toxicology and Environmental Health Hazards.
Volume 6. National Academy Press, Washington,

DC. 1986. 457p.

Descriptors: *Drinking water, *Public health, *Water pollution effects, Cancer, Laboratory methods, Mathematical models, Risk assessment, Toxicity.

Since 1977, committees of the Research Council have issued five volumes of Drinking Water and Health, each of which includes a review of toxicological data and estimates of the risks associated with specific contaminants found in drinking water. The most recently constituted Safe Drinking Water Committee conducted the study reported in this sixth volume of the series. Many of the principles examined by the committee are not limited to the exposure of humans to toxicants in drinking water. In addition, discussions of the basic principles of dose-response relationships can be found throughout the various chapters. Developmental and reproductive effects are reviewed in Chapters 2 and 3. The temporal relationships between exposure and effect are discussed in detail to provide a framework for the critical examination of dose-response relationships in laboratory animals. Chapter 2 also provides principles for extrapolating from laboratory data to determine potential developmental risks in humans. General concern has been raised about the effect of chemicals on the reproductive ability of males and nonpregnant females. In Chapter 3, the committee address this issue in detail. Many compounds have been identified as neurotoxicants in humans, and there are a number of mechanisms whereby chemicals exert neurotoxic effects. In Chapter 4, the committee examines the data on neurotoxicity in both humans and animals. Chemical carcinogenesis is discussed extensively in Chapter 5, which describes the most useful methods of short-term assessment that can be integrated into the prediction of carcinogenesis in humans. The committee uses the principles described in Chapter 8 for the assessment of risk for chemically induced cancer in humans. In Chapter 6, using physiologically and anatomically based mathematical modeling, the committee presents a method for using inhalation exposure data in estimating the kinetics of exposure by ingestion. The collection of human toxicity data through epidemiological studies is discussed in Chapter 7, which focuses on the reliability of these data in estimating human risks. The overall theme of the volume, relating dose-response relationships to estimates of human health risk, is integrated in Chapter 8, Risk Assessment. Chapter 9, is intended by the committee to serve as an example of how the principles of toxicology can be applied to quantitative analysis of risks to humans. Those principles suggested in the preceding chapters are applied whenever possible in assessing the risk from 14 chemical contaminants in drinking water. (Lantz-PTT)
W90-08157

DRINKING WATER AND HEALTH. VOLUME 9: SELECTED ISSUES IN RISK ASSESSMENT.
National Research Council, Washington, DC. Safe Drinking Water Committee.
National Academy Press, Washington, DC. 1989. 268p.

Descriptors: *DNA, *Drinking water, *Monitoring, *Risk assessment, *Water pollution effects, Chemical interactions, Laboratory methods, Public health, Toxicity.

This is the ninth volume in the series Drinking Water and Health issued by the Safe Drinking Water Committee of the Board on Environmental Studies and Toxicology of the National Research Council. It focuses on two important current topics: the first part examines the possible uses of DNA adducts (addition products) in risk assessment, and the second part examines the issue of multiple toxic chemicals in drinking water and the assessment of their health risks. As described in Part 1, studies of DNA have been rapidly refined and developed in the past few years. The ability to detect ever-smaller molecular alterations of DNA provides important opportunities for estimating and reducing public health risks associated with drinking water contaminants, foods, and workplace chemicals that bind to DNA to form adducts.

The Executive Summary of Part 1 summarizes the findings of the subcommittee. Chapter 1 describes where and how DNA adducts are formed and repaired; what is known of their relationship to protein adducts and to exposure to, and toxic effects of, contaminants; and some differences in adduct formation between humans and laboratory animals. The uses and limitations of current techniques for detecting DNA adducts and protein adducts and the outlook for the application of the techniques in toxicity testing, biologic monitoring, and epidemiology are described in Chapter 2. Chapter 3 presents the subcommittee's conclusions and recommendations. Part 2 of this volume addresses mixtures of toxic chemicals. The toxicity of chemicals is traditionally studied in terms of the effects of exposure to single toxic substances, rather than mixtures of substances. Regulatory agencies have used results of studies of single toxicants to form procedures for regulating exposure. But predicting effects of mixtures solely from knowledge of effects of their components can be erroneous. Some agents interact when combined to produce biologic responses different from those expected, and interactions and the magnitude of responses might not be considered properly. Many components of drinking water produce similar biologic effects. For example, the volatile, halogenated hydrocarbons are known to form common metabolites in mammalian systems. (Lantz-PTT)
W90-08158

EUTROPHICATION IN THE UNITED KINGDOM--TRENDS IN THE 1980S.
For primary bibliographic entry see Field 5B.
W90-08167

DRINKING WATER CRITERIA DOCUMENT FOR ASBESTOS.
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
For primary bibliographic entry see Field 5F.
W90-08169

DRINKING WATER CRITERIA DOCUMENT FOR ALDICARB.
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
For primary bibliographic entry see Field 5F.
W90-08170

WATER POLLUTION BIOLOGY: A LABORATORY/FIELD HANDBOOK.
Massachusetts Univ., Amherst.
R. A. Coler, and J. P. Rockwood.
Technomic Publishing Co., Inc., Lancaster, Pennsylvania. 1989. 107p.

Descriptors: *Bioassay, *Ecological effects, *Handbooks, *Laboratory methods, *Water pollution effects, Biological studies, Ecosystems, Field tests, Taxonomy.

Sporadic, but significant research in water pollution biology occurred well over a hundred years ago in England, France, and Germany. The chlorination of sewage effluent as a health measure in the early 1900s, however, effectively stymied further growth of the discipline. It wasn't until the 1950s in the USA that an awakening of environmental awareness caused the shift from a public health to an ecological perspective. Early investigators developed a four-pronged effort to create methodologies for the interpretation of the biological response to chemical and physical stimuli: (1) indicator organisms; (2) community structure (diversity, dominance, etc.); (3) community function (respiration and photosynthesis); and (4) bioassay and toxicity tests. These methods have been generally adopted by consulting firms and state and federal water pollution control agencies. This manual, therefore, is applications oriented and is not designed to serve the limnologist. The chemical and physical parameters of an experimental and control station measured in Chapter 1 provide the basis against which the biological data, retrieved

from the same stations, in Chapters 2, 3, and 4 are correlated. Two areas of expertise must be cultivated before this approach can be implemented. Chapter 2 is devoted to the acquisition of these skills: the identification to the generic level of the major aquatic invertebrate orders and the collection of ecologically and statistically significant samples. Have addressed community composition and structure, the perspective evolves, in Chapter 3, to an investigation of community function. The focus is on net and primary productivity in lentic and lotic habitats. The bioassay protocols delineated in the last chapter (4) provide the most precise answers of all the tools in the pollution biologist's arsenal. However, by virtue of the controlled laboratory environment demanded by this approach, it affords the weakest extrapolation to natural communities. The data are limited to narrow generalizations about the studied life stage of the species tested. (Lantz-PTT)
W90-08173

REGIONAL RELATIONSHIPS BETWEEN GEOMORPHIC/HYDROLOGIC PARAMETERS AND SURFACE WATER CHEMISTRY RELATIVE TO ACIDIC DEPOSITION.
NSI Technology Services Corp., Corvallis, OR.
For primary bibliographic entry see Field 2A.
W90-08220

QSARS BASED ON STATISTICAL DESIGN AND THEIR USE FOR IDENTIFYING CHEMICALS FOR FURTHER BIOLOGICAL TESTING.
Istituto Superiore di Sanita, Rome (Italy). Lab. di Tossicologia Comparata ed Ecotossicologia.
M. L. Tosato, S. Marchini, L. Passerini, A. Pino, and L. Eriksson.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 265-277, 1990. 8 fig, 10 tab, 24 ref.

Descriptors: *Model studies, *Molecular structure, *Risk assessment, *Structure-activity relationships, *Toxicity, *Toxicology, Aromatic compounds, Bioassay, Hazardous compounds, Path of pollutants, Statistical methods.

Quantitative structure-activity relationships (QSARs) have recently been extensively used in problems of chemical risk assessment. The use of QSAR studies as a tool for predictions of toxic/ ecotoxic effects of chemicals and identification of potentially hazardous ones is reviewed. Theoretical issues discussed are: the philosophy of QSAR, the conditions that must be fulfilled for constructing sound models, and a strategy to establish priorities for further toxicological testing. In a discussion of applications, illustrations are reported regarding how several environmentally significant chemicals are distributed into chemical classes that meet QSAR criteria for modeling and how QSAR studies are carried out. Four classes of chemicals are considered, consisting of both monofunctional and difunctional aliphatics and aromatics. The selection of the training sets through a statistical design is indispensable for constructing models that represent a particular class of chemicals in a balanced manner. Examples include chlorinated aliphatics and aliphatic alcohols. (VerNooy-PTT)
W90-08240

RISKS OF TOXIC CONTAMINANTS TO EXPLOITED FISH POPULATIONS: INFLUENCE OF LIFE HISTORY, DATA UNCERTAINTY AND EXPLOITATION INTENSITY.
Oak Ridge National Lab., TN. Environmental Sciences Div.
L. W. Barnthouse, G. W. Suter, and A. E. Rosen.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 297-311, 1990. 5 fig, 6 tab, 24 ref, append. EPA Interagency Agreement DW90031959-01-1, DOE Contract DE-AC05-84OR21400.

Descriptors: *Bioassay, *Estuarine fisheries, *Fish populations, *Life history studies, *Risk assessment, *Toxicity, *Toxicology, Bass, Chronic toxicity, Data interpretation, Menhaden, Mortality, Pollutants, Population exposure, Statistical analysis, Structure-activity relationships, Uncertainty, Water pollution effects.

Three aspects of the use of toxicity test data for population-level risk assessment were investigated: (1) the influence of life history characteristics on vulnerability to contaminant-induced stress, (2) the importance of test data availability and (3) the influence of exploitation intensity. Population-level effects of chronic contaminant exposure were quantified by coupling standard toxicity test data to matrix-type population models derived from long-term field studies of the Gulf of Mexico menhaden (Brevoortia patronus) and Chesapeake Bay striped bass (Morone saxatilis) populations. Statistical regressions were used to quantify the uncertainty inherent in using test data ranging from life cycle tests to quantitative structure-activity relationships (QSARs) to estimate effects of contaminants on the survival and reproduction parameters of the population models. Because of differences in life history, it was found that menhaden and striped bass differ in terms of their capacity to sustain the same level of contaminant-induced mortality. Changes in exploitation intensity affect the responses of both populations to the same level of additional contaminant-induced mortality. However, the quantitative effects of both factors are negligible compared to the uncertainty introduced by estimating long-term effects from short-term tests or QSARs. Results suggest that consideration of life history may be important primarily for site-specific assessments. For screening-level assessments, the substantial differences in uncertainty associated with different types of test data are of much greater concern. (Author's abstract)
W90-08243

IDENTIFICATION OF AMMONIA AS AN IMPORTANT SEDIMENT-ASSOCIATED TOXICANT IN THE LOWER FOX RIVER AND GREEN BAY, WISCONSIN.
Environmental Research Lab.-Duluth, MN.
G. T. Ankley, A. Katko, and J. W. Arthur.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 313-322, 1990. 2 fig, 5 tab, 40 ref.

Descriptors: *Ammonia, *Chronic toxicity, *Interstitial water, *Pollutant identification, *Toxicity, *Water pollution effects, Bacteria, Bioassay, Daphnia, Fox River, Green Bay, Minnow, Mortality, Sediment analysis, Sediment contamination, Selenastrum, Wisconsin.

Toxicity of sediment pore water from 13 sites in the lower Fox River/Green Bay watershed was assessed using a number of test species. Sediment pore water from the 10 lower Fox River sites exhibited acute toxicity to fathead minnow (Pimephales promelas), with 96-hour LC50s ranging from 17.4 to 40.6% pore water and Ceriodaphnia dubia, with 48-hour LC50s of 39.7 to > 100% pore water. Pore water samples from all 13 sites were chronically toxic to C. dubia; 168 hour LC50s ranged from 29.3 to 86.5% pore water. Sediment pore water from seven of the sampling sites was toxic to Selenastrum capricornutum (168-hour LC50s from 52.8 to > 100% pore water), but none of the samples were toxic to Photobacterium phosphoreum. Toxicity characterization, identification and confirmation procedures indicated that a significant amount of the acute toxicity of the pore water to fathead minnows and C. dubia was due to ammonia. The identification of ammonia, a naturally occurring compound in sediments, as a potentially important sediment-associated toxicant has implications for sediment toxicity assessment and control, not only in the Fox River and Green Bay, but in other freshwater and marine systems as well. (Author's abstract)
W90-08244

EFFECTS OF BORON ON GROWTH AND PHYSIOLOGY IN MALLARD DUCKS.
Patuxent Wildlife Research Center, Laurel, MD.
D. J. Hoffman, M. B. Camardese, L. J. Lecaptain, and G. W. Pendleton.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 335-346, 1990. 3 fig, 4 tab, 34 ref. US Bureau of Reclamation/US Fish and Wildlife Service Intra-Agency Agreement 6-AA-20-04170.

Descriptors: *Animal growth, *Boron, *Drainage water, *Ducks, *Toxicity, *Water pollution effects, Animal physiology, Aquatic plants, Bioaccumulation, Food chains, Histology, Irrigation water, Morbidity, Path of pollutants.

High concentrations of boron (B) have been associated with irrigation drainwater and aquatic plants consumed by waterfowl. Day-old mallard (Anas platyrhynchos) ducklings received an untreated diet (controls) or diets containing 100, 400, or 1600 ppm B as boric acid. Survival, growth and food consumption were measured for 10 weeks. At termination, blood and tissue samples were collected for biochemical assays and histological examination. The highest dietary concentration of B caused 10% mortality and decreased overall growth and the rate of growth (sexes combined), whereas lower concentrations of B altered growth only in females. Food consumption was lower during the first 3 weeks in the 1600 ppm group compared to controls. Hematocrit and hemoglobin were lower and plasma calcium concentration higher in the 1600 ppm group compared to controls. Plasma triglyceride concentration was elevated in all B-treated groups. Brain B concentration increased to 25 times that of controls in the 1600 ppm group. Boron accumulated less in the liver than in the brain but resulted in an initial elevation of hepatic glutathione. These findings, in combination with altered duckling behavior, suggest that concentrations of B occurring in aquatic plants could adversely affect normal duckling development. (Author's abstract)
W90-08245

TOXICITY OF ORGANIC SELENIUM IN THE DIET TO CHINOOK SALMON.
National Fisheries Contaminant Research Center, Yankton, SD. Field Research Station.
S. J. Hamilton, K. J. Buhl, N. L. Faerber, R. H. Wiedmeyer, and F. A. Bullard.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 347-358, 1990. 8 tab, 45 ref.

Descriptors: *Organometals, *Salmon, *Selenium, *Toxicity, *Water pollution effects, Bioaccumulation, Bioassay, Drainage water, Fish diets, Fish growth, Sublethal effects, Survival, Trace metals.

The toxicity of two organoselenium diets was evaluated in 90 to 120 day partial life cycle tests with two life stages of chinook salmon (Oncorhynchus tshawytscha Walbaum). One of the diets contained fish meal made from high-selenium mosquitofish (Gambusia affinis Baird and Girard) collected from the selenium-laden San Luis Drain, CA (here termed SLD diet) and the other contained meal made from low-selenium mosquitofish (collected from a reference site) fortified with selenomethionine. A 90-day study was conducted with swim-up larvae in a water-simulating dilution of San Luis Drain water in a standardized fresh water; and a 120-day study was conducted with fingerlings 70-mm long in a water of similar quality but prepared with a standardized brackish water. After 90 days of exposure in the freshwater study, survival was reduced in fish fed > or = 9.6 micrograms Se/g of either diet, and growth was reduced in fish fed > or = 5.3 micrograms Se/g of SLD diet or > or = 18.2 micrograms Se/g of selenomethionine diet. Reduced fish growth, whole-body concentrations of selenium and survival were strongly correlated to concentrations of selenium in both diets. After 120 d of exposure in the brackish-water study, survival was unaffected but growth was reduced in fish fed > or = 18.2 micrograms Se/g of SLD diet or 34.5 micrograms Se/g of selenomethionine diet. After 120 days of dietary exposure, survival during a 10 day seawater challenge test was reduced in fish fed 35.4 micrograms Se/g of either diet. In this second dietary study, concentration-response relations were observed in both dietary treatments between the dietary concentrations of selenium and all three characteristics--fish growth, whole body concentrations of selenium and survival in seawater. (Author's abstract)
W90-08246

Group 5C—Effects Of Pollution

CHRONIC TRIBUTYLTIN TOXICITY EXPERIMENTS WITH THE CHESAPEAKE BAY COPEPOD, ACARTIA TONSA.
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
S. J. Bushong, M. C. Ziegenfuss, M. A. Unger, and L. W. Hall.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 359-366, 1990. 3 tab, 40 ref. Navy contract N00039-87-C-5301.

Descriptors: *Antifoulants, *Chesapeake Bay, *Chronic toxicity, *Copepods, *Organometals, *Organotin compounds, *Tin, *Toxicity, *Water pollution effects, Bioassay, Mortality, Path of pollutants, Survival.

Repeated chronic toxicity experiments were conducted with the Chesapeake Bay zooplankter Acartia tonsa to evaluate its sensitivity to tributyltin (TBT). Experiments were initiated with A. tonsa nauplii less than 48 hours old. All tests were conducted with continuous-flow conditions and measured TBT concentrations. Results from a 9-day range finding experiment and two 6-day chronic experiments are presented. TBT test concentrations were maintained with minimal fluctuations over time and toxicity results were similar in the repeated chronic experiments. The range-finding experiment demonstrated severe reductions in survival of A. tonsa at the lowest measured concentrations (0.029 micrograms TBT/L). In the 6-day experiments, 0.023 and 0.024 micrograms TBT/L were the lowest measured TBT concentrations to significantly reduce survival relative to the controls (i.e., lowest observed effect concentration (LOEC)). No observed effect concentrations (NOEC) measured at 0.012 and 0.010 micrograms TBT/L were used to calculate chronic values of 0.016 and 0.017 micrograms TBT/L for these two experiments. A. tonsa nauplii are very sensitive to TBT relative to other estuarine organisms. These toxicity data are environmentally relevant since TBT concentrations exceeding the chronic value for A. tonsa have been reported from numerous locations in Chesapeake Bay. (Author's abstract)
W90-08247

AMBIENT TOXICITY DYNAMICS: ASSESSMENTS USING CERIODAPHNIA DUBIA AND FATHEAD MINNOW (PIMEPHALES PROMELAS) LARVAE IN SHORT-TERM TESTS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
A. J. Stewart, L. A. Kszos, B. C. Harvey, L. F. Wicker, and G. J. Haynes.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 367-379, 1990. 7 tab, 8 fig, 16 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Chlorine, *Daphnia, *Minnow, *Toxicity, *Water pollution effects, Bioassay, Chemical analysis, Cooling water, Correlation analysis, Effluents, Larvae, Mortality, Stream pollution, Survival.

Seven-day static renewal tests with fathead minnow larvae (Pimephales promelas) and Ceriodaphnia dubia were conducted monthly and results were used to assess spatiotemporal patterns in toxicity at 15 sites in 5 streams that receive discharges from the Oak Ridge National Laboratory (ORNL). The stream water samples were also analyzed for pH, conductivity, alkalinity, hardness and total residual chlorine (TRC). Relationships between the ambient toxicity test results and the chemical data were evaluated by (1) examining correlations between the two data sets across all site-test combinations and (2) principal components analyses (PCA). Growth and fecundity differed little from site to site, but survival varied greatly from test to test at some sites. Mean survival and its site-specific coefficient of variation were inversely related both for C. dubia and P. promelas (r = -0.857 and -0.810, respectively). Mortality patterns for both test species suggested that episodic events controlled overall patterns in ambient toxicity, and the C. dubia test appeared to be more sensitive than the P. promelas test. PCA identified two water quality factors (axis I, associated with hardness-conductivity, and axis II, strongly associated with TRC) that accounted for 60.5 and 17.6%, respec-

tively, of the total variance in the chemical data. Analysis showed that C. dubia survival was linked to axis II (p = 0.001) but not to axis I (p = 0.010). C. dubia fecundity was linked significantly to both (p = 0.011 and p = 0.019 for axes I and II, respectively). Neither survival nor growth of P. promelas was linked statistically to either axis. Occurrence-frequency distributions for TRC showed that concentrations high enough to kill were exceeded, on average, twice monthly at sites where survival of C. dubia and P. promelas was low. Thus, TRC, which enters ORNL streams primarily as drinking water used in once-through cooling systems, was implicated as a toxicant governing toxicity test outcomes. (Author's abstract)
W90-08248

EFFECT OF SEDIMENT TEST VARIABLES ON SELENIUM TOXICITY TO DAPHNIA MAGNA.
Wright State Univ., Dayton, OH. Dept. of Biological Sciences.
B. L. Stemmer, G. A. Burton, and S. Leibfritz-Frederick.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 381-389, 1990. 7 tab, 46 ref.

Descriptors: *Bioassay, *Daphnia, *Sediment contamination, *Selenium, *Testing procedures, *Toxicity, *Water pollution effects, Heavy metals, Lethal limit, Median tolerance limit, Mortality, Path of pollutants.

The effects of three test method variables (spiking method, sediment storage and sediment:water ratio) on solid-phase sediment toxicity of selenite-spiked sediments were investigated using Daphnia magna 48-hour acute exposures. Spiking methods compared stirring and shaking of selenite with sediments followed by toxicity testing from 4 to 72 hours. The two methods produced similar LC50 values; however, significant toxicity changes occurred over time. The effect of mixing spiked sediments from 0.5 to 48 hours showed decreased toxicity after 24 and 48 hours of shaking. Storage of selenite-spiked sediments at 4 and 25 C reveal significant differences in LC50 values between storage temperatures and with time of storage. Toxicity tended to decrease faster in sediments stored at 25 C. Sediment:water comparisons varied the volume of sediment and water used in test beakers and the sediment surface area. In general, only extreme sediment:water ratios affected survival. Varying the sediment surface area while maintaining a constant 1:4 ratio did not alter survival. An increased surface area and a decreased sediment:water ratio (1:8) decreased survival. (Author's abstract)
W90-08249

LONG-TERM MONITORING OF THE EFFECTS OF TREATED SEWAGE EFFLUENT ON THE INTERTIDAL MACROALGAL COMMUNITY NEAR CAPE SCHANCK, VICTORIA, AUSTRALIA.
Melbourne and Metropolitan Board of Works (Australia). Environmental Services Section.
V. B. Brown, S. A. Davies, and R. N. Synnot.
Botanica Marina BOTNA7, Vol. 33, No. 1, p 85-98, January 1990. 9 fig, 1 tab, 23 ref.

Descriptors: *Algae, *Algal growth, *Intertidal areas, *Water pollution effects, Australia, Outfall, Stratification, Wastewater pollution, Wave action.

The effects of the discharge of secondary-treated sewage effluent on intertidal macroalgae were assessed over an eight year period from 1980 to 1988. A number of sites at varying distances from the outfall were monitored and the results compared with a previous study carried out in 1975-6 before and after discharge commenced. In the present study, fewer species were recorded at sites close to the outfall than at more distant sites, and loss or reduction of the canopy-forming brown alga Hormosira banksii resulted in a community with less vertical stratification near the outfall. The observed changes in macroalgal communities were consistent with the effluent being transported in a southeasterly direction along the coast, with sites

near and southeast of the outfall affected and northwestern sites apparently unaffected. Cluster analyses were useful in assessing the changing relationships between site areas over time. Factors believed to be important in structuring the algal communities include distance and direction from the outfall, direct effects of effluent on both plants and animals, height of the site area relative to the low water mark, exposure to wave action, abundance of certain animals which can displace the algae, grazing effects of intertidal invertebrates and fish, and climatic variations. Continued effluent discharge during the present study probably resulted in a further reduction in large brown algae at the Cape Schanck site, and a gradual reduction in the abundance of epilithic algal turfs at the effluent-affected sites. However, the relative abundance of species in epilithic turf communities at effluent-affected sites remained fairly stable over the study period. (Author's abstract)
W90-08263

SAPROBIC CLASSIFICATION OF A HIGHLY-CONTAMINATED CUBAN ESTUARY (CLASSIFICACION SAPROBIOTICA DE UN ESTUARIO CUBANO ALTAMENTE CONTAMINADO).
Universidad de la Habana (Cuba). Dept. de Zoología.
P. A. Diaz Perez, and A. Montoto Lima.
Revista de Investigaciones Marines RIMAD2, Vol. 10, No. 1, p 89-98, 1989. 2 fig, 2 tab, 22 ref. English summary.

Descriptors: *Cuba, *Pollution index, *Water pollution effects, Biodegradation, Coliforms, Estuaries.

The composition of protozoan fauna and some chemical, bacteriological and ecological factors were determined during ten months in four stations located in the polluted Almendares River estuary, along the northern coast of Havana City. The saprobic classification for the thalassogenic brackish waters during high tide was estimated between polysaprobic and isosaprobic levels, designating an anaerobic ecosystem with very concentrated waste waters undergoing microbial decomposition and showing few vegetative organisms and acute toxicity. The calculated index S was related to BOD, number of coliform and BOD/S and coli/100.S indices with similar results. This was the first time that the saprobity system, widely used in many European countries and North America, was applied for the ecological evaluation of a Cuban locality. (Author's abstract)
W90-08282

HEALTH EFFECTS OF A THORIUM WASTE DISPOSAL SITE.
New Jersey Medical School, Newark. Dept. of Preventive Medicine and Community Health.
G. R. Najem, and L. K. Voyce.
American Journal of Public Health AJHEAA, Vol. 80, No. 4, p 478-480, April 1990. 3 tab, 14 ref.

Descriptors: *Path of pollutants, *Public health, *Radioactive waste disposal, *Radioactivity effects, *Thorium, *Waste dumps, *Water pollution effects, Case studies, Human diseases, New Jersey, Population exposure, Radium, Risk assessment, Soil contamination, Stream pollution, Teratogenic effects, Uranium.

The effects of residing in the vicinity of a thorium waste disposal site were examined in a case-control study of 112 households. The site was located on 6.5 acres in Wayne, New Jersey. Soil samples revealed thorium-232, radium-238, and uranium-238 in the contaminated regions. Water samples from Sheffield Brook and the drainage ditch showed mainly alpha and beta activity. The exposed population included 76 households within three blocks adjoining contaminated areas, while the unexposed group included all houses located nine and ten blocks distant from the contaminated areas. Medical data were collected by interview, and relative risk ratios of diseases and adverse birth outcomes were calculated. A higher prevalence of birth defects, relative risk ratio 2.1, and liver dis-

eases, relative risk ratio 2.3, was found among the exposed than the unexposed group. The small number of study participants and wide confidence intervals precluded drawing definite conclusions from the data. (MacKeen-PTT)
W90-08283

EVALUATION OF JOINT TOXICITY OF CHLORINE AND AMMONIA TO AQUATIC COMMUNITIES.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
J. Cairns, B. R. Niederlehner, and J. R. Pratt.
Aquatic Toxicology AQTODG, Vol. 16, No. 2, p 87-100, March 1990. 2 fig, 6 tab, 35 ref. USAF Grant 85-0324.

Descriptors: *Ammonia, *Aquatic life, *Chlorine, *Periphyton, *Species diversity, *Synergistic effects, *Toxicity, *Water pollution effects, Algae, Metabolism, Path of pollutants, Ponds, Protozoa, Regression analysis.

Periphytic communities on artificial substrates were exposed to chlorine and ammonia, alone and in combinations. The species richness of protozoans decreased with increasing toxicant concentrations. Species richness was reduced by 20% in 2.7 micrograms per liter (microg/L) chlorine, 15.4 microg/L un-ionized ammonia, and a combination of 1.2 microg/L chlorine and 16.8 microg/L ammonia. Interaction between toxicants was significant and effects of mixtures were less than additive, especially at higher concentrations. Multiple regression was used to determine a response surface model accounting for 73.4% of the variation in species richness. Algal biomass and community metabolism measures were less sensitive to stress and showed different patterns of joint action. (Author's abstract)
W90-08284

MORPHOMETRIC ANALYSIS OF PHOSPHATE AND CHROMIUM INTERACTIONS IN CYCLOTELLA MENEGHINIANA.
Michigan Univ., Ann Arbor. Center for Great Lakes and Aquatic Sciences.
D. Lazinsky, and L. Sicko-Goad.
Aquatic Toxicology AQTODG, Vol. 16, No. 2, p 127-140, March 1990. 6 fig, 2 tab, 43 ref. EPA Grant R807516.

Descriptors: *Chromium, *Cyclotella, *Diatoms, *Phosphates, *Plant morphology, *Synergistic effects, *Water pollution effects, Cytology, Electron microscopy, Heavy metals, Quantitative analysis.

Quantitative electron microscopy was used to evaluate interactive effects of chromium additions and phosphate nutrient status on the diatom Cyclotella meneghiniana. Cells of differing phosphate status were exposed to hexavalent chromium for seven days and morphological changes in both phosphate alone and phosphate and chromium treatments were observed. Changes in chloroplast relative volume and number/volume were observed in all treatments. Changes in mitochondrial and vacuolar volume and an increase in presumed autophagic activity were apparent in all chromium treatments. An increase in polyphosphate was also found in most chromium treated cells. Quantitative morphological changes with chromium in this study showed similarities to results obtained with other heavy metals. (Author's abstract)
W90-08287

EFFECTS OF CLIMATE CHANGE ON U.S. IRRIGATION.
Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.
For primary bibliographic entry see Field 2B.
W90-08357

EFFECTS OF DECREASING HEAVY METAL CONCENTRATIONS ON THE BIOTA OF BUTTLE LAKE, VANCOUVER ISLAND, BRITISH COLUMBIA.
Ministry of Environment, Nanaimo (British Co-

lumbia). Waste Management Branch.
For primary bibliographic entry see Field 5G.
W90-08381

COMBINED EFFECTS BETWEEN ATRAZINE, COPPER AND PH, ON TARGET AND NON TARGET SPECIES.
Centre des Sciences de l'Environment, Metz (France).
S. Roberts, P. Vasseur, and D. Dive.
Water Research WATRAG, Vol. 24, No. 4, p 485-491, April 1990. 4 fig, 3 tab, 1+ ref. Ecotoxicity Commission of the French Ministry of Environment Grant No. 85140.

Descriptors: *Algae, *Atrazine, *Copper, *Herbicides, *Pesticide toxicity, *Protozoa, *Synergistic effects, *Toxicity, *Water pollution effects, Bacteria, Microorganisms, Multiple regression analysis.

Binary mixtures of atrazine (herbicide) and copper were studied in three microorganisms: a bacterium, a protozoan and a microalga. Factorial experiments were carried out to detect interactive effects and toxicity results were interpreted with multiple regression analysis. The levels of concentrations tested on algae were close to those found in aquatic environments. The specific toxicity of atrazine to photosynthetic cells and the broad activity spectrum of copper which is toxic to the three species tested was confirmed. No significant interactions were found between atrazine (up to 100 microgram/l) and copper (up to 25 microgram/l $Cu(++)$) on algae. No interactive effects were registered on protozoans either. A synergistic effect does occur on bacteria, but at such concentrations (10 mg/l) that this effect is not considered ecologically meaningful. (Author's abstract)
W90-08392

COMMUNITY SIMILARITY AND THE ANALYSIS OF MULTISPECIES ENVIRONMENTAL DATA: A UNIFIED STATISTICAL APPROACH.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 7C.
W90-08395

INFLUENCE OF STARVATION ON WATERBORNE ZINC ACCUMULATION BY RAINBOW TROUT, SALMO GAIRDNERI, AT THE ONSET OF EPISODIC EXPOSURE IN NEUTRAL SOFT WATER.
Dundee Univ. (Scotland). Dept. of Biological Sciences.
R. D. Handy, and F. B. Eddy.
Water Research WATRAG, Vol. 24, No. 4, p 521-527, April 1990. 3 fig, 2 tab, 30 ref. NERC studentship reference no. TFS/86/ANE/3.

Descriptors: *Bioaccumulation, *Fish diets, *Tissue analysis, *Trout, *Water pollution effects, *Zinc, Gills, Hydrogen ion concentration, Toxicity.

Zinc accumulation by whole gill, skin, body mucus and blood plasma were measured during short term episodic exposure in acidic and neutral soft water using fed fish and also in neutral soft water using starved fish. Water pH did not influence zinc accumulation in 1 hour using fed fish indicating that pH effects on zinc accumulation occur over a longer time period. The gill tissue and body mucus were primary sites of zinc accumulation in fed and starved fish, while plasma zinc increases were observed only in fed fish during a 2 hour episode of neutral soft water. Starved fish gill tissue and body mucus accumulate zinc quicker than fed fish tissues. The increased zinc accumulation by starved fish may be explained in terms of an increased contribution by waterborne zinc to total body zinc levels, achieved partly by changes in mucus ion content and also by possible effects of starvation on tissue zinc distribution. (Author's abstract)
W90-08397

ACID STRESS AND AQUATIC MICROBIAL INTERACTIONS.

CRC Press, Inc., Boca Raton, Florida. 1989. 176p. Edited by Salem S. Rao.

Descriptors: *Acid rain effects, *Environmental effects, *Microbiological studies, *Path of pollutants, *Water pollution effects, Biochemistry, Chemical interactions, Chemical reactions, Ecological effects, Geochemistry, Hydrogen ion concentration, Microorganisms.

Ecological interactions have been defined as the study of the relation of organisms to their environment. Many, if not all, of the important transformations occurring in an ecosystem are due to the presence and activities of microbes. Yet, environmental processes such as those responsible for the adaptation of microbial communities to extreme environments in order to bring about key microbiological reactions are not fully understood. This volume presents information and techniques which are at the leading edge of microbial acid rain research and addresses a number of topical and important issues of global concern. These are microbial responses to low pH, biogeochemical processes, cycling of organic matter, and microbial interactions with higher forms of biota. (See W90-08415 thru W90-08423) (Lantz-PTT)
W90-08414

EFFECTS OF LAKE ACIDIFICATION ON MICROBIAL POPULATIONS AND PROCESSES.
Brock Univ., St. Catharines (Ontario). Dept. of Biological Sciences.
S. S. Rao, and B. K. Burnison.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 21-31, 7 fig, 38 ref.

Descriptors: *Acid rain effects, *Bacterial physiology, *Ecological effects, *Lake acidification, *Microorganisms, *Ontario, *Water pollution effects, Bacteria, Bioindicators, Hydrogen ion concentration, Lake sediments, Microbiological studies, Population dynamics.

Bacteriological data collected for water and sediment cores from some Ontario lakes receiving acidic deposition indicate that bacterial populations and activities were diminished by 20 to 30% under acidic conditions. A pH value below 5.5 appeared to be critical for active populations. Measurements such as direct counts of total and respiring bacteria, heterotrophic plate counts, nitrifying and sulfur cycle bacteria, microbial activities (O_2 consumption rates and organic substrate utilization), and bacterial morphology and physiology were considered. Diminished microbial activity in surface sediments resulted in an increased accumulation of organic matter. This increased storage of organic matter in the sediments is tied into the recycling of nutrients and hence can affect the behavior of the whole lake ecosystem. The greatest complexity in terms of bacterial cell structure diversity and development of extracellular products is found at pH 5.0; low pH stress has a marked effect on the bacterial morphology per se and/or the selection of dominant types. Low bacterial activity in acidified lakes may be the result of certain cell structural changes. The physiological alterations in bacteria may be significant as stress-indicator if related to cell surface exchange and/or membrane permeability properties associated with nutrient transport of toxic substances. (See also W90-08414) (Lantz-PTT)
W90-08416

BIOGEOCHEMICAL CYCLING OF ORGANIC MATTER IN ACIDIC ENVIRONMENTS: ARE MICROBIAL DEGRADATIVE PROCESSES ADAPTED TO LOW PH.
Environmental Research Lab., Athens, GA.
R. Benner, D. L. Lewis, and R. E. Hodson.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 33-45, 7 fig, 1 tab, 35 ref. NSF Grants BSR 8215587 and BSR 8114823.

Descriptors: *Acid rain effects, *Acidic water, *Biodegradation, *Cycling nutrients, *Environmental effects, *Swamps, *Water pollution effects,

Group 5C—Effects Of Pollution

Corkscrew Swamp, Detritus, Florida, Georgia, Hydrogen ion concentration, Microbial degradation, Microbiological studies, Okefenokee Swamp, Wetlands.

Microorganisms are the major agents responsible for the biogeochemical cycling of nutrients that often limit overall productivity of ecosystems and, in part, determine ecosystem structure. Comparisons of microbial activities between circumneutral and naturally acidic environments can provide insights into the long-term adaptability of microbial populations to acid stress, and thus may indicate which microbially mediated processes, if any, are sensitive to low pH conditions. The rates of microbial degradation of a variety of dissolved and particulate substrates in water and sediment from the Okefenokee Swamp, in southern Georgia, and Corkscrew Swamp, a circumneutral pH wetland in southern Florida, were compared. These two wetland ecosystems share many of the same types of plant communities and both are peat-forming systems. As in many wetlands, streams, and small lakes, vascular plant detritus is a major source of organic matter in these two freshwater swamps. The relationship between pH and rates of biodegradation of organic substrates was determined for natural microbial assemblages and for several bacterial isolates from these environments. Results from these studies suggest that microbial degradative processes that rely on extracellular enzymes are depressed at low pHs, whereas the microbial utilization of low molecular weight compounds that can be directly transported into cells is not substantially affected by variations in pH from 4 to 8. The study also suggests that microbial populations will not 'adapt' for the rapid utilization of lignocellulosic substrates at low pHs. (See also W90-08414) (Lantz-PTT)
W90-08417

MICROBIAL BIOGEOCHEMICAL PROCESSES IN A NATURALLY ACIDIC WETLAND, THE OKEFENOKEE SWAMP.
Georgia Univ., Athens. Dept. of Microbiology.
For primary bibliographic entry see Field 2H.
W90-08418

EPILITHIC MICROBIAL POPULATIONS AND LEAF DECOMPOSITION IN ACID-STRESSED STREAMS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
A. V. Palumbo, P. J. Mulholland, and J. W. Elwood.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 69-90, 8 fig, 6 tab, 60 ref. EPRI Contract RP2326-1 and DOE Contract DE-AC05-84OR1400.

Descriptors: *Acid rain effects, *Acid streams, *Aluminum, *Biodegradation, *Decomposing organic matter, *Leaves, *Water pollution effects, Bacteria, Hydrogen ion concentration, Organic matter, Productivity.

The number of bacteria on decomposing leaf material (direct counts of acridine orange-stained bacteria) and bacterial production on leaf material and on rock surfaces (incorporation of tritiated thymidine into DNA) were measured as part of a study of the effects of acidification on microbial communities in streams. The number of bacteria on leaf material ranged from 33 to 124 mega-cells/gm dry weight; this was not significantly different among streams of different pH and aluminum concentration, and increased over the first 4 weeks of incubation, and was relatively constant thereafter at all sites. There was no significant dilution of added thymidine by unlabeled internal or external pools of thymidine in measurements of bacterial production on leaf material. Bacterial production on both leaf and rock surfaces was significantly greater in streams with higher pH ($>$ 5.5) than at matched sites in nearby streams with lower pH ($<$ 5.0). However, differences in productivity among sites were not evident until after 2 weeks of incubation of leaf material in the streams, and significant differences could not be generated in short-term ($<$ 48-hr) transplants of rock material from high to low pH sites. Therefore, the effects of acidification on bacteria do not appear to be due to acute toxicity. Because Al concentration and pH co-vary in these streams (high Al concentrations at low pH), the observed depression of bacterial production at lower pH sites may be due to chronic effects of high concentrations of both H(+) and Al(3+) or may be indirectly due to the effects of acidification on the invertebrate grazing community in the streams. (See also W90-08414) (Author's abstract)
W90-08420

ALGAL ASSEMBLAGES IN ACID-STRESSED LAKES WITH PARTICULAR EMPHASIS ON DIATOMS AND CHRYSOPHYTES.
Queen's Univ., Kingston (Ontario). Dept. of Biology.
S. S. Dixit, and J. P. Smol.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 91-114, 7 fig, 1 tab, 156 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Algae, *Bioindicators, *Chrysophytes, *Diatoms, *Literature review, *Water pollution effects, Hydrogen ion concentration, Phytoplankton, Population dynamics, Taxonomy.

This literature review reveals that many acidification-related changes have been identified in algal communities, including shifts in species composition, and changes in species richness, diversity, and biomass. Some generalizations can be made about the distribution of algal assemblages in acid-stressed lakes. Among planktonic taxa Merismopedia, peridinum, and gymnodinium are common, whereas Mougeotia, Zygnema, Phormidium, and Spirogyra often dominate the benthic community. As lakes acidify, planktonic algal production may decline, while benthic taxa, often forming thick algal mats, become more important primary producers. Changes in species richness and community composition appear to be more reliable markers of acidification than biomass. The presence and abundance of many diatom and chrysophyte taxa is closely associated with lake water pH. Acidobiontic and acidophilous taxa (Tabellaria quadriseptata, Asterionella ralfsii var. americana, Frustulia rhomboides, various Eunotia species, Mallomonas hamata, M. hindonii, Synura echinulata, and others) occur commonly in acidic lakes, whereas circumneutral and alkaline taxa (A. formosa, Cyclotella ocellata, C. meneghiniana, M. caudata, M. pseudocoronata, S. curtispina, and others) dominate in circumneutral and alkaline waters. Because of the specific pH indicator value of these siliceous algae, various quantitative models have been developed that calibrate assemblages to lake-water pH. These models are widely used to interpret the history of lake acidification in many regions of North America and Europe. (See also W90-08414) (Lantz-PTT)
W90-08421

DIATOM STRATIGRAPHY IN ACID-STRESSED LAKES IN THE NETHERLANDS, CANADA, AND CHINA.
Brock Univ., St. Catharines (Ontario). Dept. of Biological Sciences.
M. Dickman, and S. S. Rao.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 115-143, 10 fig, 90 ref, append.

Descriptors: *Acid lakes, *Acid rain effects, *Canada, *China, *Diatoms, *Lake sediments, *The Netherlands, *Water pollution effects, Algae, Hydrogen ion concentration, Literature review, Paleolimnology, Population dynamics, Sulfates, Sulfur.

The literature dealing with diatom stratigraphy in three regions of the world experiencing heavy sulfur loading in (1) The Netherlands; (2) central Canada; and (3) east central China is reviewed. The rate of acidification as inferred from downcore diatom stratigraphies in each of these regions is compared. These three locations were chosen because they represent: (1) high concentrations of SO2 associated with the long-range transport of acidic precipitation (The Netherlands), (2) the largest point source of SO2 emissions in the world (Sudbury, Canada), and (3) the highest concentration of small-scale, sulfur-rich coal-burning operations (Pacific Basin of China). Lakes which have acidified during the last 30 to 40 years have a characteristic assemblage of diatoms. This assemblage is frequently dominated by acid-tolerant and trace metal-tolerant diatoms which are well preserved in the sediments of most acid lakes. Thus, it is possible to use the downcore changes in diatom-relative abundance to infer changes in paleo pH. Lakes undergoing eutrophication are unlikely candidates for acidification, presumably due to alkalinity generated during photosynthesis. All else being equal, the larger the volume of a lake the more time it will require to acidify or deacidify. (See also W90-08414) (Lantz-PTT)
W90-08422

PROTOZOAN BACTERIVORY IN ACIDIFIED WATERS: METHODS OF ANALYSIS AND THE EFFECT OF PH.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
S. C. Tremaine, and A. L. Mills.
IN: Acid Stress and Aquatic Microbial Interactions. CRC Press, Inc., Boca Raton, Florida. 1989. p 145-169, 10 fig, 10 tab, 112 ref.

Descriptors: *Acid rain effects, *Acidic water, *Bacteria, *Ecological effects, *Food chains, *Sediments, *Water pollution effects, Acidification, Amphipods, Benthos, Hydrogen ion concentration, Mollusks, Productivity, Protozoa, Rotifers.

The role of protozoans as bacterivores in aquatic ecosystems has been described in many studies. Bacteria decompose 10-50% of the total fixed carbon in marine water column systems, and 40-80% in lake ecosystems. Consumption of bacteria has been documented in protozoans, amphipods, rotifers, prosobranchs, and bivalves. It has been hypothesized that bacterivorous protozoans (ciliates, amoebae, and flagellates) are the dominant consumers of bacteria, and therefore represent a critical link in energy transfer through aquatic food webs. The effects of acidification on bacterivorous protozoans has been virtually ignored in acidification studies, with the notable exceptions of research on several Florida, Ontario, and Michigan wetlands and lakes. Data are presented on protozoan grazing rates under acid stress. From the ecosystem point of view, the data collected, along with the research discussed, indicate that pH does not directly affect protozoans or their activities. The species present may be different at various pH values, but the function of the community appears to remain intact. The indirect effects of acidification on algal productivity and, in turn, the supply of organic matter to bacteria is an important controlling factor in bacterivorous protozoan distribution. Adequate organic substrate for high rates of bacterial productivity may be available in sediments, allowing for abundant protozoan communities to develop in the benthos when they cannot develop in the water column. Research into the synergistic effects of metals and acid on sediment protozoan communities could clarify the effect of these confounded variables. (See also W90-08414) (Lantz-PTT)
W90-08423

SURFACE AND VIRULENCE PROPERTIES OF ENVIRONMENTAL VIBRIO CHOLERAE NON-O1 FROM ALBUFERA LAKE (VALENCIA, SPAIN).
Valencia Univ. (Spain). Dept. of Microbiology.
C. Amaro, A. E. Toranzo, E. A. Gonzalez, J. Blanco, and M. J. Pujalte.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 4, p 1140-1147, April 1990. 1 fig, 3 tab, 51 ref. Comision Asesora de Investigacion Cientifica y Technica (PR83-3166).

Descriptors: *Bacterial physiology, *Pathogenic bacteria, *Vibrio, *Water pollution effects, Albufera Lake, Bacterial toxins, Hemagglutination, Microbiological studies, Public health, Spain, Toxicity, Valencia.

A total of 140 environmental Vibrio cholerae non-O1 isolates from Lake Albufera, Spain, together with several culture collection strains from both environmental and clinical sources, were studied in relation to hemagglutination, surface hydrophobicity, and the enzymatic, hemolytic, cytotoxic, and enterotoxic activities of their extracellular products. A total of 78 and 62% of the strains produced hemagglutinins and exohemagglutinins. The surface properties varied along the growth curves. The non-O1 strains displayed strong enzymatic and hemolytic activities, except for esculin hydrolysis. Of 26 non-O1 isolates selected for cytotoxin and enterotoxin production, 23 showed a wide spectrum of cytotoxic effects on cell lines of poikilothermic and homoiothermic species, but they were weakly enterotoxigenic in the infant mouse test. Despite the low enterotoxic capability exhibited by V. cholerae non-O1 strains from surface waters near Valencia (Spain), the high numbers of V. cholerae present during the warm season constitute a public health hazard, since most of them are producers of other putative virulence factors. (Sand-PTT)
W90-08429

SURVIVAL AND DEVELOPMENT OF LAKE TROUT (SALVELINUS NAMAYCUSH) EMBRYOS IN AN ACIDIFIED LAKE IN NORTH-WESTERN ONTARIO.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
L. C. Mohr, K. H. Mills, and J. F. Klaverkamp.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 236-243, February 1990. 5 fig, 4 tab, 33 ref.

Descriptors: *Acid lakes, *Acid rain effects, *Acidification, *Embryonic growth stage, *Fish populations, *Hydrogen ion concentration, *Trout, *Water pollution effects, Acid rain, Canada, Fish eggs, Fish physiology, Limnology, Mortality, Ontario.

Survival and development of lake trout (Salvelinus namaycush) embryos from L223 in the Experimental Lakes Area, northwestern Ontario, were evaluated from 1979 (pH 5.6) to 1982 (pH 5.1). Survival of L223 embryos was not significantly correlated to lake pH during experimental acidification. Also, embryo mortality in L223 was not significantly different from that of lake trout embryos in two reference lakes, L224 and L468. Survival of L223 embryos was not improved when they were incubated in nonacidified lakes. Embryo mortality was highest in all lakes (33-81%) within 15 d of fertilization. Mortality was negligible from Day 15 until the termination of the seasonal observations (Day 120 or 150). High variability in embryo survival existed between individual females within a single lake. The mean size of eggs from L223 lake trout decreased significantly from 1979 to 1982. Recruitment failures occurred in L223 from 1980 to 1982. It is hypothesized that trout recruitment failure in L223 occurred between the posthatching period (spring) and actual recruitment into the population as young-of-the-year (fall) and that embryo mortality in this lake was not critical to population recruitment. (Author's abstract)
W90-08432

BIOTRANSFORMATION AND OTHER TOXICOLOGICAL AND PHYSIOLOGICAL RESPONSES IN RAINBOW TROUT (SALMO GAIRDNERI RICHARDSON) CAGED IN A LAKE RECEIVING EFFLUENTS OF PULP AND PAPER INDUSTRY.
Kuopio Univ. (Finland). Dept. of Physiology.
For primary bibliographic entry see Field 5B.
W90-08451

INDICES OF TRIAZINE TOXICITY IN CHLAMYDOMONAS GEITLERI ETTL.
Manitoba Univ., Winnipeg. Dept. of Botany.
D. L. Francois, and G. G. C. Robinson.
Aquatic Toxicology AQTODG, Vol. 16, No. 3, p 205-228, April 1990. 8 fig, 4 tab, 48 ref.

Descriptors: *Herbicides, *Path of pollutants, *Toxicity, *Water pollution effects, Algae, Algal growth, Atrazine, Bioassay, Chlorophyll, Fate of pollutants, Growth rates, Simazine, Terbutryn.

The toxicity of three triazine herbicides (atrazine, simazine and terbutryn) was examined in unialgal batch cultures of Chlamydomonas geitleri Ettl. Changes in growth and chlorophyll accumulation were used as indices of toxicity. Herbicide-induced chlorophyll fluorescence was also used to describe the primary effect of the three triazines. The subsequent effect on inhibition of CO_2 assimilation was also examined. Some cultures were pre-treated with 2.46 micro molar atrazine, and subsequently treated with varying concentrations of atrazine in an attempt to induce increased tolerance. Terbutryn was the greatest inhibitor of growth and CO_2 fixation, with toxicity being two orders of magnitude greater then for atrazine and simazine. Its half saturation constant for chlorophyll fluorescence was the lowest, suggesting its affinity for binding at the active site was 32 to 50 times greater than that for atrazine and simazine, respectively. Atrazine and simazine were not significantly different in their inhibition of CO_2 fixation or at inducing chlorophyll fluorescence. However, atrazine inhibited growth 2 to 3.5 times more effectively than did simazine. Inhibition of chlorophyll synthesis was most obvious with exposure to atrazine and terbutryn, with only a slight accumulation in chlorophyll occurring at the lowest concentrations of these herbicides. A strong stimulation in chlorophyll synthesis, which was observed with simazine exposure, was interpreted as being a tolerance mechanism. The obvious stimulation in growth and CO_2 fixation observed with simazine was perhaps due to the stimulatory effect of the herbicide on protein synthesis. Pre-conditioning of cultures with 2.46 micro-molar atrazine did not enhance tolerance as evidenced by unchanged growth, CO_2 fixation, and chlorophyll fluorescence response upon subsequent treatment with atrazine. (Author's abstract)
W90-08452

FISH IN THE POLLUTED NORTH SEA.
Bundesforschungsanstalt fuer Fischerei, Hamburg (Germany, F.R.). Inst. fuer Kuesten- und Binnenfischerei.
V. Dethlefsen.
Dana DANADZ, Vol. 8, No. 1989, p 109-129, 1989. 7 fig, 3 tab, 80 ref.

Descriptors: *Coastal waters, *Estuaries, *Fish diseases, *North Sea, *Reviews, *Water pollution effects, Denmark, England, Netherlands, West Germany.

During the last two centuries aquatic environments in Europe experienced a progressing state of pollution. With the beginning of the industrial revolution severe impact of pollutants on the stocks of fishes and benthic organisms were demonstrated in all major North Sea estuaries. Open North Sea areas including coastal zones were generally thought to be not influenced until the end of 1970. Reports indicated low dissolved oxygen concentrations in German and Danish coastal waters impacting fish abundance and distribution and reports on high prevalences of diseases of fish, especially the flatfish dab (Limanda limanda). Between the time of the first detection and today intensive epidemiological studies of fish diseases have been carried out in the North Sea. The major results were: high prevalences of externally detectable diseases and liver abnormalities in flounder and dab. Increased infection rates were not restricted to onshore waters. Present studies indicate disease levels in the whole of the North Sea. Certain hot spots of exceptionally high disease prevalence were encountered: the German Bight, the Dogger Bank, and Dutch, Danish and English coastal waters. Increased disease prevalence was also found in areas far offshore. High contamination levels were found in dab in areas of high disease prevalence, although no simple relationships seemed to exist. The disease prevalences are interpreted to be a deviation from normal. The interpretation whether they are anthropogenically caused is at present disputed and will be a matter for discussion in the future. This is due to the fact that causes for diseases are multifactorial and can be exclusively be natural. On the other hand many of the known anthropogenically introduced contaminants occurring in elevated levels in the biota of the North Sea have the potential to trigger the diseases mentioned. (Author's abstract)
W90-08456

FISH REPRODUCTION AND THE IMPACT OF ACIDIFICATION IN THE KYRONJOKI RIVER ESTUARY IN THE BALTIC SEA.
Finnish Game and Fisheries Research Inst., Helsinki.
L. Urho, M. Hilden, and R. Hudd.
Environmental Biology of Fishes EBFID3, Vol. 27, No. 4, p 273-283, April 1990. 4 fig, 5 tab, 23 ref.

Descriptors: *Acid rain effects, *Acidic water, *Acidification, *Estuaries, *Fish, *Larvae, *Reproduction, *Spawning, *Water pollution effects, Acidic soils, Baltic Sea, Kyronjoki River, Macrophytes, Spatial distribution, Temporal distribution, Water temperature.

Several freshwater species use the Kyronjoki River estuary as a spawning and nursery area. The main reasons for this seem to be the morphology of the estuary, the abundance of shelter provided by aquatic macrophytes, high food production and favorable temperature conditions. Acidification of the estuary due to drainage from acidic soils has made part of the estuary unsuitable for fish reproduction. In addition, year to year fluctuations in the acidity of the estuarine water have affected the reproductive success of several species. The severity of the effects of the acidification at the population level is determined by the spatial and temporal distribution of the larvae and juveniles. As the habitat requirements of the fish larvae and juveniles change with the ontogenic development, their distribution changes in time. Furthermore, the habitats alter with the yearly succession of the macrophyte vegetation. The most conspicuous change in spatial distribution was the seaward migration of juvenile fish observed in most of the species. The significance of the migration from the point of view of acidification is that autumn minima in water quality are likely to affect a much smaller part of the juvenile stock than minima in spring or summer. (Author's abstract)
W90-08458

DELAYED SPAWNING OF PERCH, PERCA FLUVIATILIS L., IN ACIDIFIED LAKES.
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
For primary bibliographic entry see Field 2H.
W90-08461

ATTRACTION OF ZEBRAFISH, BRACHYDANIO RERIO, TO ALANINE AND ITS SUPPRESSION BY COPPER.
Texas A and M Univ., College Station. Dept. of Biology.
C. W. Steele, D. W. Owens, and A. D. Scarfe.
Journal of Fish Biology JFIBA9, Vol. 36, No. 3, p 341-352, March 1990. 1 fig, 4 tab, 42 ref. Texas A and M University Sea Grant Program grant 4A79AA-D-00127.

Descriptors: *Attractants, *Copper, *Fish behavior, *Pollutants, *Water pollution effects, Alanine, Zebrafish.

Preference responses of zebrafish to 0.001, 0.0001 and 0.00001 M alanine (Ala) were concentration-dependent. Behavioral responses to Cu and Cu + Ala mixtures were also assessed. Zebrafish avoided 100 and 10 micrograms Cu/L, but not 1 microgram/L. Mixtures of 0.001 M Ala + 100 micrograms Cu/L and 0.0001 M Ala + 10 micrograms Cu/L were avoided as intensely as was Cu alone. Responses to 0.001 M Ala + 10 or 1 microgram Cu/L and 0.0001 M Ala + 1 microgram Cu/L did not differ statistically from controls (no detectable preference or avoidance). These results demonstrate, firstly, that a concentration of a pollutant avoided by itself (10 micrograms Cu/L) may not be avoided when encountered with an attractant chemical stimulus (Ala) and may suppress the preference for an attractant stimulus, and secondly,

that a concentration of a pollutant not avoided by itself and not considered deleterious (1 microgram Cu/L) suppresses attraction to Ala (an important constituent of prey odors for many fishes). (Author's abstract)
W90-08462

STUDIES OF CONTAMINANT AND WATER QUALITY EFFECTS ON STRIPED BASS PRO-LARVAE AND YEARLINGS IN THE POTO-MAC RIVER AND UPPER CHESAPEAKE BAY IN 1988.
Johns Hopkins Univ., Silver Spring, MD. Applied Physics Lab.
L. W. Hall, M. C. Ziegenfuss, S. J. Bushong, M. A. Unger, and R. L. Herman.
Transactions of the American Fisheries Society TAFSAI, Vol. 118, No. 6, p 619-629, November 1989. 1 fig, 8 tab, 21 ref. U.S. Fish and Wildlife Service cooperative agreement 14-16-0009-87-924.

Descriptors: *Ammonia, *Cadmium, *Chesapeake Bay, *Chlordane, *Copper, *Lead, *Potomac River, *Susquehanna River, *Water pollution effects, *Water quality, *Zinc, Elk River, Larvae, Mortality, Sassafras River, Temperature effects, Toxicity, Water temperature.

Simultaneous on-site and in situ studies of prolarval and yearling striped bass Morone saxatilis were conducted in the Potomac River during the 1988 spawning season. Various water quality and contaminant conditions were monitored during these experiments. In situ experiments on yearlings and monitoring of water quality and contaminants were also conducted in the Susquehanna, Elk, and Sassafras rivers of the Upper Chesapeake Bay. Survival of striped bass prolarvae ranged from 1-20% in the Potomac River during three concurrent 96-h on-site and in situ experiments; survival of control fish was 78% or greater. Survival of striped bass yearlings was 15% or less during 28-d in situ tests at two Potomac River field locations; survival of control fish was 100%. Mortality of prolarvae in the Potomac River was likely caused by a combination of Cd, Pb, chlordane, and sudden drops in temperature. Mortality of yearlings was possibly caused by a combination of Cd, Pb, Zn, chlordane, and ammonia. Survivals of striped bass yearlings tested in 28-day tests in the Susquehanna, Elk, and Sassafras rivers were 57, 100, and 100%, respectively; survival of control fish was 100%. Mortality of striped bass in the Susquehanna River may have been partly caused by Cu and Pb concentrations; however, other nonidentified factors were likely more important. Water quality problems were not detected in the Elk or Sassafras rivers. (Author's abstract)
W90-08465

SENSITIVITY OF ENDEMIC SNAKE RIVER CUTTHROAT TROUT TO ACIDITY AND ELEVATED ALUMINUM.
National Fisheries Contaminant Research Center, Jackson, WY. Jackson Field Station.
D. F. Woodward, A. M. Farag, M. E. Mueller, E. E. Little, and F. A. Vertucci.
Transactions of the American Fisheries Society TAFSAI, Vol. 118, No. 6, p 630-643, November 1989. 2 fig, 8 tab, 64 ref. U.S. Forest Service cooperative agreement 28-C6-382.

Descriptors: *Acid rain effects, *Acidic water, *Aluminum, *Fish physiology, *Toxicity, *Trout, *Water pollution effects, DNA, Embryonic growth stage, Fish eggs, Gills, Hydrogen ion concentration, Larvae, Potassium, RNA, Snake River, Sodium, Wyoming.

Acidic episodes in waters of the western USA do not last as long and are not as intense as those in the eastern USA, but it was found that the native western cutthroat trout Oncorhynchus clarki is sensitive to even brief reductions in pH. In laboratory studies, fish were exposed to acidity (pH 4.5-6.5) alone or in the presence of Al during the first 7 d of the freshly fertilized egg, eyed embryo, alevin, or swim-up larva stages of development. Following exposure to acidity and Al, eggs and fish were held under control water quality conditions to 40 d posthatch to assess effects of the exposure on sub-

sequent development. Reductions in pH from 6.5 to 6.0 in low-calcium water (1.4 mg/L) did not affect survival, but reduced growth of fish in the early life stages. The presence of as little as 50 micrograms Al/L at low pH further reduced growth and reduced survival. The most sensitive indicators of stress were loss of ions (determined from whole-body sampling) and reduced swimming in alevins, reduction in the ratio of RNA:DNA, feeding inhibition, and pathology of gill tissue in swim-up larvae. A pH of 6.0 and 50 micrograms Al/L reduced whole-body Na by 72% and K by 50% in alevins. Reduction in the RNA:DNA ratio, correlated with lower growth rates, were observed in swim-up larvae exposed to pH 5.5 and 50 micrograms Al/L. Exposure to 50 micrograms Al/L at pH 6.0 reduced swimming activity of alevins by 68% and feeding rates of swim-up larvae by 67%. In the presence of 50 micrograms Al/L, pathological changes in gill tissue were observed in swim-up larvae exposed to pH of 6.0 or less. Although acidification is not widespread in the western USA, cutthroat trout have a narrow margin of safety between conditions that currently exist and those at which pH and Al reduce survival and growth. (Author's abstract)
W90-08466

EVALUATION OF TOXICITY OF VOLATILE ORGANIC CHEMICALS: GENERAL CONSIDERATIONS.
National Research Council, Washington, DC. Board on Environmental Studies and Toxicology.
For primary bibliographic entry see Field 5F.
W90-08527

EPIDEMIOLOGIC STUDIES AND RISK ASSESSMENT OF VOLATILE ORGANIC COMPOUNDS IN DRINKING WATER.
National Cancer Inst., Bethesda, MD. Environmental Epidemiology Branch.
For primary bibliographic entry see Field 5F.
W90-08528

CHANGING SYNOPTIC WEATHER PATTERNS, RAINFALL REGIMES AND ACID INPUTS IN THE EAST MIDLANDS, U.K.
Loughborough Univ. of Technology (England). Dept. of Geography.
For primary bibliographic entry see Field 2B.
W90-08580

CHANGES IN THE COMPOSITION OF THE DANUBE RIVER BASIN BIOCENOSIS RESULTING FROM ANTHROPOGENIC INFLUENCES.
Novi Sad Univ. (Yugoslavia). Inst. of Biology.
V. Pujin.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 13-30, 1990. 2 fig, 43 ref.

Descriptors: *Danube River, *Ecological effects, *Water pollution effects, *Water pollution sources, Algae, Aquatic life, Chlorophyta, Ecosystems, Eutrophication, Phytoplankton, Species diversity, Zooplankton.

In the last several decades, anthropogenic processes have brought about a number of changes in the ecosystem of the Danube River. Data on the water quality of the Danube and its tributaries are many, thanks to the organized and systematic coordination of research in all the Danubian countries. Hydroengineering schemes and wastewater loads from industry, agriculture and urban centers have changed the conditions of life both in the water and along the banks. The belts of flood forests which had been characteristic for the Danube have been reduced. The decrease of flooded areas and introduction of atochthonous tree species has negatively affected certain fish species which used these areas as spawning places. The composition of phytoplankton in the Danube is characterized by the domination of Bacillariophyta over the whole course, while in the lower reaches, in addition to these algae, there are Chlorophyta, the dominant group in warmer periods. The number of phytoplankton in the last ten years has multiplied, as a result of eutrophication and backwater effects in

certain sections, due to the construction of impoundments and hydropower plants. In keeping with the increased eutrophication, there are also blooms of blue-green algae in certain sections. The zooplankton consists of: Protozoa, Rotatoria, Cladocera, Copepoda, and larvae of Dreissena polymorpha. The benthos fauna has undergone some major changes. In certain sections, some snail species have disappeared (Theodoxus danubias, Ephemeroptera and Trichoptera) while the incidence of Oligochaeta increased, particularly Tubifex and Limnodrilus genera. According to microbiological indicators, water quality of the Danube may be classified as category II and III. Other biological parameters also indicate betamesosaprobic to beta-alphamesosaprobic conditions. Some species from the ichthyofauna of the Danube have disappeared (Acipenseridae and Umbra krameri). The self-purification capacity of the Danube is considerable, which is the factor that helps preserve the above mentioned quality. However, future adverse influences may seriously aggravate the situation. (Agostine-PTT)
W90-08606

ECOTOXICOLOGICAL STUDIES ON THE KILIAN BRANCH AND DELTA OF THE RIVER DANUBE.
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 5B.
W90-08608

LONG TERM INVESTIGATION OF THE RIVER DANUBE WATER QUALITY IN THE YUGOSLAV SECTION ACCORDING TO MICROBIOLOGICAL PARAMETERS.
Novi Sad Univ. (Yugoslavia). Inst. of Biology.
S. Gajin, M. Gantar, M. Matavulj, and O. Petrovic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 39-44, 1990. 3 fig, 16 ref.

Descriptors: *Bioindicators, *Danube River, *Laboratory methods, *Path of pollutants, *Water pollution effects, *Water quality, Bacteria, Bacterial physiology, Bioassay, Ecological effects, Heterotrophs, Microbiological studies, Plankton, Yugoslavia.

The estimation of water quality of the Danube River in the Yugoslav section in the period from 1975 to 1988, was based on the numbers of heterotrophs, the ratio of the total number of bacterioplankton and the number of heterotrophs (T/H ratio), and enzymatic activity. Water samples for microbiological analysis were taken seasonally, from the middle region of the river, at seven sampling sites throughout Yugoslavia. Total number of bacterioplankton was estimated in the period 1982-1988 by direct count on Sartorius filters, and the number of heterotrophs was estimated in the period 1975-1988. Numbers of bacteria belonging to different physiological groups (heterotrophs, oligotrophs, proteolytic bacteria, amylolytic bacteria, and sucrose utilizing bacteria) were determined by cultivation methods. Estimation of water quality was carried out according to Kohl's classification, which is based on the number of heterotrophs, and according to the T/H index. According to the number of heterotrophs, there is a conspicuous deterioration of Danube water quality, indicated by the shift from class I-II and II, in the period 1975-1978, to class III and III-IV, in recent years. Numbers of total bacterioplankton were lower in the recent years, while the percentage of heterotrophs in total number increased. This would suggest a decrease of oligotrophic microflora in the river ecosystem. The increase in phosphatase activity during the period 1982-1988 also indicates the deterioration of the water quality in the Yugoslav section of the Danube. The data presented here should be considered seriously, since any further loading of the river water with organic pollutants could reach the limits of self-purification capacities and lead to the breakdown of the dynamics of biological processes. (Agostine-PTT)
W90-08609

EFFECTS OF WARM WASTEWATERS FROM THERMAL POWER STATIONS ON ECOSYSTEMS OF THE SAVA AND THE VELIKA MORAVA, TRIBUTARIES OF THE DANUBE.
Institute for Biological Research, Belgrade (Yugoslavia). Dept. of Ichthyology.
For primary bibliographic entry see Field 6G.
W90-08625

IMPACT OF THE CHERNOBYL ACCIDENT ON THE RADIOACTIVITY OF THE RIVER DANUBE.
Novi Sad Univ. (Yugoslavia). Inst. of Physics.
For primary bibliographic entry see Field 5B.
W90-08631

ESTIMATION OF ENVIRONMENTAL RISK DUE TO POLLUTED SEDIMENT.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
I. Bogardi, W. E. Kelly, A. Bardossy, and E. Z. Stakhiv.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 227-234, 1990. 1 fig, 10 ref.

Descriptors: *Dredging wastes, *Fate of pollutants, *Model studies, *Risk assessment, *Sediment contamination, *Water pollution effects, *Water pollution sources, Carcinogens, Danube River, Economic aspects, Industrial wastes, Mathematical models, Rivers, Sediments.

A risk-cost evaluation method has been developed for sediment management applicable to the Danube Basin. Specifically, the environmental risk and the cost due to excavation and disposal of polluted sediment are evaluated and traded off in order to select sound management alternatives. Two main objectives of sediment management are considered: to minimize the cost of management and to minimize the environmental risk. The economically optimal solution may not be realized due to the environmental risk involved. The environmental risk has several components such as human carcinogenic risk, human noncarcinogenic risk, and ecological risk related to a number of species. A trade-off analysis called composite programming is used: (1) to aggregate components of environmental risk considering different sources and compositions of polluted sediment in the river channel and/or reservoirs, and (2) to find an alternative of sediment management which provides the best compromise between the cost and environmental risk involved. (Author's abstract)
W90-08635

EFFECT OF MERCURY ON THE SURVIVAL OF DAPHNIA MAGNA.
Sarajevo Univ. (Yugoslavia). Inst. for Water Resources Development.
I. Brkovic-Popovic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 241-146, 1990. 2 fig, 3 tab, 8 ref.

Descriptors: *Bioassay, *Bioindicators, *Heavy metals, *Laboratory methods, *Mercury, *Toxicity, *Water pollution effects, Alkalinity, Crustaceans, Daphnia, Hardness.

The toxic effect of mercury on Daphnia magna has been the subject of numerous studies. Daphnia is considered to be a very suitable test organism for studying the toxicity of heavy metals because it is very sensitive, has a short life-span, and is very important as a food for fish. A study was conducted to determine the toxic effect of mercury on the survival of Daphnia magna over its whole life-span at two temperatures and with two diluents of different total hardness and alkalinity. The studies were carried out over a wide range of mercury concentrations (from acutely lethal to the so-called 'no effect on the median life-span' concentration), in order to provide a better basis for predicting the 'no effect' concentration from short-term toxicity tests and to indicate the influence of abiotic factors on the results. The median lethal time (LT 50) for each concentration of mercury was determined on the basis of mortality curves. The experiments were carried out using two diluents of different total hardness (46 and 119 mg/L as CaCO3), at

two temperatures (20 C and 25 C). A comparison of the LT 50s of the control organisms with the LT 50s of the test organisms at mercury concentrations of 0.0075 and 0.0050 mg/L showed that the chemical characteristics and temperature of the media tested did not affect the range of the 'no effect' concentration. However, the incipient median lethal concentration (LC 50), and the time required for its appearance, did depend on the combination of the abiotic factors tested. (Agostine-PTT)
W90-08637

EVALUATION OF WASTE WATER POLLUTION.
Ljubljana Univ. (Yugoslavia). Faculty of Natural Sciences and Technology.
For primary bibliographic entry see Field 5A.
W90-08638

RISK MANAGEMENT OF ACCIDENTAL WATER POLLUTION: AN ILLUSTRATIVE APPLICATION.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 7C.
W90-08641

IMPACT OF MUNICIPAL WASTEWATER ON THE QUALITY OF THE RIVER SAVA.
Zagreb Univ. (Yugoslavia). Faculty of Civil Engineering.
S. Tedeschi.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 275-280, 1990. 3 fig, 6 ref.

Descriptors: *Sava River, *Wastewater pollution, *Water pollution effects, *Yugoslavia, Biological oxygen demand, Dissolved oxygen, Industrial wastewater, Municipal wastewater, Oxygen depletion, Wastewater treatment.

The River Sava in Yugoslavia is very polluted in certain sections. At times, the dissolved oxygen is completely exhausted (1.0 to 3.0 mg oxygen/L) resulting in frequent massive fish kills. The water quality has significantly deteriorated during the past few decades, due to the industry developed in the watershed and the increased population in the area. Especially heavy pollution loads come from the greater Zagreb area (153 tons biochemical oxygen demand for 5 hours per day). Treating the wastewater from Zagreb could upgrade the water quality of the Sava, and 68 to 72% oxygen saturation could be achieved even under the most unfavorable conditions. Particular attention should be given to the choice of the treatment process, due to the planned construction of multi-purpose reservoirs along the Sava. (Author's abstract)
W90-08642

URBAN DEVELOPMENT IN THE DANUBIAN BASIN AND ITS EFFECTS ON WATER QUALITY--ASPECTS AND TRENDS.
Executive Council of the Socialist Republic of Serbia, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 4C.
W90-08643

5D. Waste Treatment Processes

URBAN SURFACE WATER MANAGEMENT.
Valparaiso Univ., IN.
For primary bibliographic entry see Field 4A.
W90-07551

EFFECT OF WINTER HEAT LOSS ON TREATMENT PLANT EFFICIENCY.
Portland State Univ., OR. Dept. of Civil Engineering.
S. A. Wells.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 34-39, January/February 1990. 9 fig, 2 tab, 18 ref.

Descriptors: *Cold regions, *Mathematical models, *Wastewater facilities, *Wastewater treatment,

Activated sludge, Aeration, Biological wastewater treatment, Chlorination, Clarifiers, Finite difference methods, Numerical analysis, Sedimentation, Temperature effects.

Heat losses from wastewater treatment plant units can affect the efficiency of anaerobic and aerobic biological processes (temperature dependence of cell kinetics, gas solubility, oxygen diffusion, and gas surface transfer), chlorine disinfection (temperature dependence of percent HOCL versus OCL), suspended solids removal by sedimentation (temperature dependence of viscosity and the possibility of thermal short-circuiting), and other processes such as ammonia stripping, nitrification and denitrification, dissolved air flotation, and carbon adsorption. The temperature regime of a typical wastewater treatment plant was modeled using numerical and analytical techniques. The following exposed tanks were chosen: a rectangular primary clarifier, aeration basin, secondary clarifier, and chlorine contact chamber. One-dimensional dispersive flow in each tank was assumed. The temperature distribution was modeled numerically for each basin by a Crank-Nicholson implicit finite difference technique. An analytical approach was also used to calculate the steady-state case. Calculations were made for hypothetical winter meteorological conditions, plant flow, plant basin design, and inflow temperature. Effects of increasing plant recycle rate between the secondary clarifier and the aeration basin and of covering the aeration basin on heat losses were noted. During winter conditions, analyses indicated that thermal short circuiting may occur in the clarifiers and the chlorine contact basin and that vertical turbulent motions due to surface cooling may inhibit particle sedimentation. (Tappert-PTT)
W90-07624

NITRIFICATION PERFORMANCE OF A PILOT-SCALE TRICKLING FILTER.
Veenstra and Kimm, Inc., West Des Moines, IA.
H. A. Gullicks, and J. L. Cleasby.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 40-49, January/February 1990. 14 fig, 1 tab, 8 ref.

Descriptors: *Cold regions, *Nitrification, *Trickling filters, *Wastewater facilities, *Wastewater treatment, Biofilms, Chemical oxygen demand, Dissolved oxygen, Hydraulic loading, Iowa, Pilot plants.

Nitrification in trickling filters is flux limited and depends upon the rate of transport of reactants into the biofilm. The nitrification performance of a pilot-scale, separate stage trickling filter plant was evaluated with emphasis on cold-climate performance. A 14 month pilot-scale nitrification study was conducted on a two-stage trickling filter plant at Ames, Iowa. The pilot plant consisted of a pretreatment tower and a nitrification tower. Samples were collected at the dosing siphon discharge of the nitrification tower. Nitrification rates were examined at a temperature of 10C; rates observed at other than 10C were converted to a 10C basis using the Nernst-Einstein equation. Nitrification performance was diminished at less than 60 to 65% of bulk-liquid DO saturation. Previous theories that nitrification could not occur in the presence of bulk-liquid filterable COD concentrations in excess of 27 mg/L were refuted. Total hydraulic loading rates greater than 0.8 L/sq.m/sec and intermittent dosing were detrimental to winter operation. Nitrifying performance was restored during winter operation by continuous dosing and lower hydraulic loading rates. (Tappert-PTT)
W90-07625

COLD-CLIMATE NITRIFYING BIOFILTERS: DESIGN AND OPERATION CONSIDERATIONS.
Veenstra and Kimm, Inc., West Des Moines, IA.
H. A. Gullicks, and J. L. Cleasby.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 50-57, January/February 1990. 7 fig, 2 tab, 25 ref.

Group 5D—Waste Treatment Processes

Descriptors: *Biofilters, *Nitrification, *Wastewater facilities, *Wastewater treatment, Dissolved oxygen, Iowa, Temperature effects.

A 14 month pilot-scale nitrification study was conducted at the Ames, Iowa water pollution control plant. A design curve for separate-stage, nitrifying biofilters with influent wastewater temperatures of 10C was constructed with data from studies conducted by other researchers. The performance of the Ames, Iowa, pilot-scale nitrifying biofilter plant was compared to the design curve predictions. Nitrification performance was lower in winter than in summer due to reduced transfer of oxygen into the biofilm at winter temperatures. The lower nitrification performance at colder wastewater temperatures is the result of the following factors: (1) lower diffusivities of reactants in the bulk liquid and in the biofilm; (2) low bulk liquid dissolved oxygen concentrations compared with saturation dissolved oxygen; (3) higher carbonaceous oxygen demand; (4) greater sloughing and partial plugging associated with winter operation; and (5) possibly the lower metabolic rate of the micro-organisms although this effect would be small in flux-limited processes. Operating procedures that increase oxygen transfer will increase the rate of nitrification observed. A cross-flow medium with a high specific surface area appeared more prone to plugging than a medium with a lower specific surface area. The average, effective media surface area was between the values predicted by two theoretical equations. Start-up of nitrifying biofilters and restoration of nitrification performance is possible under winter conditions. (Tappert-PTT)
W90-07626

FACTORS GOVERNING METHANE FLUCTUATIONS FOLLOWING SHOCK LOADING OF DIGESTERS.
ENEA, Bologna (Italy). Lab. Interventi Dimostra-tiri.
D. P. Smith, and P. L. McCarty.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 58-64, January/February 1990. 8 fig, 2 tab, 29 ref. NSF Grant No. CEE 82-15436.

Descriptors: *Anaerobic digestion, *Digestion, *Methane, *Numerical analysis, *Wastewater treatment, Mathematical models, Model studies, Municipal wastewater.

Anaerobic treatment provides for the majority of waste stabilization in municipal wastewater treatment plants and is useful for the treatment of a wide variety of industrial wastewaters as well. The process is complex because of the many microorganisms included in the overall transformations to methane gas, and for this reason it is often difficult to understand the variations in performance that occur. A non-steady-state energetic/kinetic model was developed to predict methane production, organic substrate and product concentrations, hydrogen partial pressure, and bacterial mass concentrations in a methanogenic continuously stirred tank reactor (CSTR) receiving ethanol and propionate as organic substrates for growth. The non-steady-state model consists of a system of eight first-order nonlinear ordinary differential equations describing substrate and bacterial concentrations for each of four biologically mediated reactions. The model was used to simulate a shock-load perturbation of the steady-state CSTR by sudden addition of a large quantity of ethanol and propionate. A cyclic pattern in methane production, corresponding to sequential utilization of substrates and intermediates was predicted by the model. Experimentally measured methane production showed a similar cyclic pattern, but was more erratic due to reduced product formation which shifted methane production to latter stages in the transient. (Tappert-PTT)
W90-07627

CONTROL OF ANAEROBIC GAC REACTORS TREATING INHIBITORY WASTEWATERS.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
G. F. Nakhla, M. T. Suidan, and J. T. Pfeffer.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 65-72, January/February 1990. 7 fig, 5 tab, 13 ref. DOE Grant No. DE-AC21-80MC14713.

Descriptors: *Anaerobic digestion, *Coal wastes, *Granular activated carbon, *Industrial wastewater, *Wastewater facilities, *Wastewater treatment, Activated carbon, Activated sludge, Ammonia, Aromatic compounds, Chemical oxygen demand, Cyanide, Hydraulic loading, Hydrocarbons, Phenols.

Conversion of coal to gaseous liquid fuels generates wastewaters that are contaminated with phenolic compounds, polyaromatic hydrocarbons, ammonia, cyanide, thiocyanate, and a variety of suspected mutagenic substances. Operational techniques for reducing the cost of treating a coal gasification wastewater (CGWW) using expanded bed anaerobic granular activated carbon (GAC) bioreactors require an understanding of the relationship between several components of the process train, including the hydraulic retention time, solids retention time, and influent concentration of non-biodegradable inhibiting compounds. The wastewater toxicity is overcome by periodic partial replacement of the reactor medium with virgin GAC. A two-phase study of CGWW treatment processes was conducted, using two-stage anaerobic filters. The first phase of the study was devoted to determining the minimum mass of GAC that needs to be replaced. The second phase investigated the dependence of system performance on hydraulic retention time and volumetric COD loading rate. Finally, the impact of waste strength on treatability was assessed through the operation of three anaerobic reactors with 30, 60, and 100% wastewater. With a COD loading rate of 4.85 kg COD/cu m/d, the minimum adsorptive capacity required for the stable treatment of CGWW using a fluidized bed GAC anaerobic reactor was 0.678 GAC/ g influent COD. No major benefit was realized with higher replacement rates. The second phase of the investigation identified advantages of treating diluted wastewater, although related problems such as increased volume of wastewater are not addressed. (Tappert-PTT)
W90-07628

BIODEGRADATION OF 2-CHLOROPHENOL USING IMMOBILIZED ACTIVATED SLUDGE.
New Jersey Inst. of Tech., Newark. Biotechnology Research Group.
S. S. Sofer, G. A. Lewandowski, M. P. Lodaya, F. S. Lakhwala, and K. C. Yang.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 73-80, January/February 1990. 12 fig, 5 tab, 19 ref.

Descriptors: *Activated sludge, *Biodegradation, *Chlorinated hydrocarbons, *Wastewater treatment, *Water pollution treatment, Biomass, Groundwater pollution, Hazardous wastes, Kinetics, Model studies, Organic compounds.

The technique of using immobilized microorganisms is recognized as a promising method for treatment of hazardous and toxic wastes. Biodegradation of 2-chlorophenol was studied using immobilized activated sludge. System response to variation in temperature and concentration of 2-chlorophenol was studied in an air-sparged reactor. A recirculation reactor, run in a batch mode, was used to study kinetic parameters such as recycle rate, biomass loading, and spiked concentration of 2-chlorophenol. The system response was examined following changes in 2-chlorophenol concentration, flow rate, and biomass loadings. Stoichiometric amounts of free chloride detected at the end of the experiments confirmed mineralization of 2-chlorophenol. A nonlinear regression model was used to verify and evaluate the kinetic parameters for the removal of 2-chlorophenol. The model was modified to accommodate the removal of 2-chlorophenol by stripping. A physically strong bead structure was obtained by optimizing concentrations of sodium alginate and calcium chloride. Kinetic constants for the rate equations determined under varying conditions of flow, chlorophenol concentrations, and biomass loading, are important in scale-up and design of reactors for treating groundwater and hazardous wastes in which unusually high concentrations of organic compounds are observed. (Tappert-PTT)
W90-07629

LOW-LEVEL ALKALINE SOLUBILIZATION FOR ENHANCED ANAEROBIC DIGESTION.
Southern Illinois Univ. at Carbondale. Dept. of Civil Engineering and Mechanics.
B. T. Ray, J. G. Lin, and R. V. Rajan.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 81-87, January/February 1990. 3 fig, 5 tab, 20 ref.

Descriptors: *Anaerobic digestion, *Bases, *Sludge, *Sludge treatment, Chemical oxygen demand, Lime, Sodium hydroxide, Volatile solids, Waste disposal.

Anaerobic digestion is the most common form of secondary sludge stabilization, having significant advantages over other processes used to stabilize organic sludges. The technique provides a lower volume of stabilized sludge than aerobic digestion, has lower nutrient requirements, and requires no oxygen. A low-level, ambient temperature alkaline solubilization process has been investigated for its ability to enhance the anaerobic digestion of waste activated sludge. The pretreatment process consists of adding 20 meq of alkali/L, followed by anoxic mixing for 24 hours. Both lime and sodium hydroxide were evaluated. Pretreatment using either chemical improves anaerobic digestion, although sodium hydroxide provides better performance. Pretreatment using sodium hydroxide improves volatile solids (VS) removals in the range of 25 to 35% over no pretreatment and increases gas production from 29 to 112% over the control sludge. VS and COD removals for sodium hydroxide pretreated sludge at a 7.5-day retention time were similar to the VS and COD removals without pretreatment at a 20-day retention time. (Tappert-PTT)
W90-07630

ADSORBER COLUMN DIAMETER: PARTICLE DIAMETER RATIO REQUIREMENTS.
Akron Univ., OH. Dept. of Civil Engineering.
W. B. Arbuckle, and Y. F. Ho.
Journal - Water Pollution Control Federation JWPFA5, Vol. 62, No. 1, p 88-90, January/February 1990. 3 fig, 3 ref.

Descriptors: *Activated carbon, *Adsorption, *Wastewater treatment, Design criteria, Experimental design, Laboratory methods.

When considering activated carbon adsorption for the treatment of wastewaters, column testing is the principal design tool. The contaminant concentration in the column effluent is monitored and a breakthrough curve obtained; professional judgment is used to scale up to full-scale treatment. When performing these small-scale column studies, it is frequently desirable to minimize the column diameter so the volume of waste to be tested is minimized. To maintain mass transfer considerations identical to those of a full-scale column, the superficial velocity (volumetric flow divided by the column cross-sectional area) should be maintained in the anticipated design range of 5 to 25 m/h(2 to 10 gpm/sq ft). In addition, the column diameter should be considerably larger than the particle diameter to eliminate wall effects. Most researchers recommend a minimum column diameter:particle diameter ratio of at least 20:1. Experiments were performed using a variety of synthetic wastewaters and column diameter:particle diameter ratios ranging from 7:1 to 37:1. The experiments indicate that ratios as low as 7:1 could be used without adversely affecting the breakthrough curve due to wall effects. This result is attributed to the different physical characteristics of liquids compared to the gases used in the wall effect models. (Author's abstract)
W90-07631

TREATMENT AND DISCHARGE TO A POTW: THE STRINGFELLOW EXPERIENCE.
Environmental Protection Agency, San Francisco,

CA. Region IX.
For primary bibliographic entry see Field 5G.
W90-07633

SMALL WASTEWATER TREATMENT PLANTS IN SWITZERLAND.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).
M. Boller, and G. Deplazes.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 1-8, 1990. 5 fig, 3 tab, 7 ref.

Descriptors: *Biological wastewater treatment, *Switzerland, *Wastewater treatment, Extended aeration, Planning, Trickling filters.

The removal of small pollution sources in rural areas is one of the present and future activities of the environmental authorities in Switzerland. The number of small treatment plants that still have to be constructed is estimated to be 40-50% of the existing plants. Since the pollution problems from small wastewater sources are usually not severe and the investment costs per capita are relatively high, the existing small treatment plants are often designed, operated and maintained with insufficient care. New efforts for establishing procedural and design guidelines for engineers and authorities are under way. A proper design calls for detailed information on wastewater characteristics and on the receiving water, and for a sound experience with conventional and new treatment methods. Several extreme conditions like low temperatures, high diurnal and seasonal fluctuations of flow and concentration of the wastewater (esp. tourist resorts) and of the receiving water (e.g. residual flow of impounded water for hydro-power), and the application of economic and reliable processes, do not allow a straight copy of the treatment systems applied in the larger plants. Innovative and appropriate processes and process modifications are needed for the treatment of small wastewater sources. (Author's abstract)
W90-07771

SMALL SEWAGE TREATMENT PLANTS AND WASTEWATER REUSE IN CYPRUS.
Hydrotech, Limassol (Cyprus).
I. Hadjivassilis.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 9-16, 1990. 2 fig, 3 tab, 5 ref.

Descriptors: *Activated sludge, *Aeration, *Biological treatment, *Cyprus, *Wastewater treatment, *Water use, Coasts, Sewage treatment, Irrigation, Tertiary treatment.

The rapid tourist development in the coastal areas of Cyprus resulting in higher water consumption, the protection of environment and resources and the needs of reuse of wastewater, contributed to the improvement of local technology for sewage treatment and wastewater reuse for irrigation. In the last ten years, due to the lack of central sewerage systems, approximately two hundred small wastewater treatment plants have been installed, mainly in coastal areas of the island. The method applied for the biological treatment is the activated sludge extended aeration process. The tertiary treatment based on high-speed depth filtration consists of two vertical pressure multilayer filters, working in series. Additionally, chemicals are injected for disinfection, coagulation/flocculation allowing the production of high quality of water. Plants regularly maintained are operating with very good results, so that the treated water has the following characteristics: biochemical oxygen demand < 5 mg/L, suspended solids < 5 mg/L, turbidity < 3 NTU, residual chlorine 1.0 to 1.5 mg/L. The water can be used for unrestricted irrigation. The installation of small sewage treatment plants and the wastewater reuse for irrigation in Cyprus is a profitable investment, preventing at the same time the pollution of the environment. (Author's abstract)
W90-07772

SEWAGE TREATMENT FOR SMALL LOCAL AUTHORITIES: CHOICE OF PROCESS AND RECENT TRENDS IN FRANCE.
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Cestas Principal (France). Div. Qualite des Eaux.
Y. Racault, and A. Vachon.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 17-24, 1990. 5 fig, 2 tab, 4 ref.

Descriptors: *Biological treatment, *France, *Wastewater treatment, Activated sludge, Lagoons, Trickling filters.

France has a large number of small rural waste treatment plants. A fairly wide range of technologies suitable for small local authorities has been developed in recent years. The choice of process is now based on a detailed analysis of the limitations imposed by local conditions, with particular regard to those involving the quality objectives for the receiving environment. The main processes used are presented, together with the design basis generally applied. An overview is presented of the situation of France's small treatment plants, through an analysis of a sample of 976 plants with a capacity of less than 2000 inhabitant-equivalents in 11 mainly rural departments covering 13 % of France's surface area. The distribution of the processes used and the evolution of the choices adopted are analyzed with regard to the size of the plants. Over one third of the total consists of plants with a size under 400 inhabitant-equivalents, and a vast majority (65 %) concerns towns of less than 800 inhabitant. This breakdown can be explained by the large number of small towns, many of them having their own treatment plant. Activated sludge is the predominant treatment process, with nearly 50 % of the total, followed by lagooning (27 %), and trickling filters (11 %). Biological discs and other processes account for a very small part of the total. The activated sludge process, widely used in all size classes ten years ago, has been gradually replaced by extensive processes, essentially where the capacity is less than 800 inhabitant-equivalents. In some departments, local practices have a great influence over the choice of process. (Author's abstract)
W90-07773

OPERATIONAL PERFORMANCE OF PACKAGE SEWAGE TREATMENT PLANTS IN NORTH WEST ENGLAND.
North West Water Authority, Warrington (England).
F. E. Greaves, B. Thorp, and R. F. Critchley.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 25-32, 1990. 6 fig, 2 tab, 3 ref.

Descriptors: *Aeration, *Biological wastewater treatment, *England, *Wastewater treatment, Biological contactors, Contactors, Extended aeration.

North West Water Authority owns and operates 21 rotating biological contactors and 7 package extended aeration plants. The rotating biological contactors have performed effectively, reliably and cheaply. Site visits are required up to three times a week for simple routine maintenance, while desludging is required periodically, typically three to nine times a year. The prefabricated extended aeration plants generally perform well but typically with more demanding operational requirements and higher capital and electricity costs than the rotating biological contactors. The Authority has concluded that the rotating biological contactor is the primary option for sewage treatment for small communities. (Author's abstract)
W90-07774

SMALL WASTEWATER TREATMENT PLANTS IN NORWAY.
Norges Tekniske Hoegskole, Trondheim.
H. Odegaard, and R. Storhaug.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 33-40, 1990. 2 fig, 4 tab, 4 ref.

Descriptors: *Biological wastewater treatment, *Chemical wastewater treatment, *Norway, *Wastewater treatment, Activated sludge, Biofilms, Biofilters.

About 70 % of the total number of advanced (biological, chemical, or biological/chemical)
wastewater treatment plants in Norway are small (100-2000 population equivalents). More than half of the small plants (55%) are based on biological/chemical treatment. Simultaneous precipitation and post precipitation based on the activated sludge process is dominating even if systems based on biofilm processes are gaining more and more popularity. The State Pollution Control Authority has made recommendations on design of small wastewater treatment plants. Two systems are recommended; one based on a low loaded activated sludge process with querning of particulate matter as pretreatment and with a separate waste sludge holding tank, and one based on a low loaded biofilm system (biofilter, rotating biological contactor, etc.) with a large septic tank serving both as pretreatment and waste sludge holding tank. (Author's abstract)
W90-07775

COMPARISON OF VARIOUS SYSTEMS FOR ON-SITE WASTEWATER TREATMENT.
Witteveen and Bos, Deventer (Netherlands).
F. A. Fastenau, J. H. J. M. van der Graaf, and G. Martijnse.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 41-48, 1990. 3 fig, 3 tab, 3 ref.

Descriptors: *Biological wastewater treatment, *On-site wastewater treatment, *Septic tanks, *Wastewater treatment, Infiltration pits.

Diffuse pollution, caused by direct discharges from individual houses, small built-up nuclei, farms, camp-sites, etc., for which connection to central wastewater treatment systems is unfeasible, may be significantly reduced by on-site treatment. Based on a large scale research, including intensive field-research work on 14 systems of different types and sizes in a range equal to population equivalents (p.e.) of 5-200 persons, 8 different types of system were compared: pre-treatment (septic) tank (PTT) + infiltration trench, PTT + infiltration pit, PTT + elevated filtration bed, PTT + sand filters, PTT + rotating biological contactor, PTT + trickling filter, activated sludge system, separate treatment of 'black' and 'gray' water. The comparison involved technological features such as removal efficiency, reliability, operational and maintenance aspects, environmental impacts and land claims, together with economical features showing significant differences. Advantages and disadvantages of each system are highlighted to enable a selection of suitable systems to be made. When no limiting factors are present, it was found that, in general, infiltration systems (infiltration pits; infiltration trenches) have the best features for on-site treatment up to 100 p.e. For larger capacities, or when infiltration is not possible, the rotating biological contactor will be the best solution mainly because of the lower costs. (Author's abstract)
W90-07776

USACERL'S EXPERIENCES WITH SMALL WASTEWATER TREATMENT PLANTS IN THE USA.
Construction Engineering Research Lab. (Army), Champaign, IL.
E. D. Smith, and R. J. Scholze.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 49-56, 1990. 4 ref.

Descriptors: *Aeration, *Biological wastewater treatment, *Wastewater treatment, Anaerobic treatment, Composting, Latrines, Pathogens.

The Environmental Division of the United States Army Corps of Engineers Construction Engineering Research Laboratory (USACERL) responsibility for environmental quality technology research to support Army missions. Part of that mission is to develop and improve water pollution control technology through research, development, testing and evaluation. This paper presents a review of collected experience of one of the Corps of Engineers research laboratories in the area of small systems for wastewater treatment. Remote site waste management options were investigated focusing on composting latrines and aerated vault latrines. Composting latrines are chambers in which wastes

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and organic bulking agents are placed for biological and physical breakdown by aerobic decomposition. This is different from conventional composting such as is done with sewage sludge, which produces thermophilic conditions capable of killing pathogens that are present. Data have shown little evidence of temperature increases capable of killing pathogens, indicating that continuous composters must rely on detention time and unfavorable conditions for pathogen kill. Conventional vault latrines have problems such as unpleasant odors, unsanitary conditions and vector problems such as flies and mosquitoes. Aeration by means of bubble aeration units is applicable both for new construction and retrofit conditions. Air supplied continuously to the waste supports the growth of microorganisms, which break down the wastes into carbon dioxide and water. Aerated vault latrines were found to treat the water biologically reducing the biochemical oxygen demand levels and eliminating odors associated with anaerobic treatment while producing an acceptable user environment. The potential for exposure of latrine users and maintenance personnel to pathogenic bacteria and other organisms in aerosols and liquid and solid wastes of four existing types of remote site latrines in close spatial proximity was investigated. The results indicated that exposure to potential pathogens through aerosols is low for all the considered technologies. (Agostine-PTT)
W90-07777

USE OF REED BED TREATMENT SYSTEMS IN THE UK.
Water Research Centre, Stevenage (England).
P. F. Cooper, J. A. Hobson, and C. Findlater.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 57-64, 1990. 1 fig, 4 tab, 4 ref.

Descriptors: *Artificial wetland treatment, *Biological wastewater treatment, *Land treatment, *Reed bed treatment systems, *Wastewater treatment, England, Hydraulic conductivity, Nitrogen removal, Phosphorus removal.

This paper summarizes the British experience of Reed Bed Treatment Systems (RBTS) for sewage treatment over the past three years. It includes a list of the 26 systems which have been built together with their design details including length, width, slope, media, and the loading they are designed for. It is still too early yet to make firm conclusions on the UK beds, since most have only gone through two growing seasons. However, they seem promising for the situation where biochemical oxygen demand (BOD) and suspended solids (SS) removal are the prime requirements. There has not been much sign of phosphorous and nitrogen removal. Many of the beds built in Europe which have used soil as the bed medium have had problems with overland flow (and hence poor performance). This can be reduced to some extent by using a flat surface, but with soils which have a low hydraulic conductivity there will still be surface flow. Gravel systems have not suffered from this so much and have provided good (filtration) removal of SS from the start. For inlet flow distribution, the recommendation is to use a simple pipe with 'tees' or orifices which can be adjusted, discharging onto a zone of large stones. A number of different outlet beds have been used. Generally a slotted pipe has been run along the base of a stone collector. For construction and design the recommendation is the use of a flat surface to allow flooding for weed control and to maintain overland flow. Propagation has been shown to be successful using seedlings. Clumps of reeds have also proved successful. Rhizomes have taken longer to produce good coverage. The performance of the British beds indicates that the reed bed treatment systems may be adequate for BOD and SS removal, but the removal of phosphorous and nitrogen is not as high as predicted elsewhere. (Agostine-PTT)
W90-07778

DANISH EXPERIENCE WITH EMERGENT HYDROPHYTE TREATMENT SYSTEMS (EHTS) AND PROSPECTS IN THE LIGHT OF FUTURE REQUIREMENTS ON OUTLET WATER QUALITY.
Aarhus Univ. (Denmark). Botanical Inst.
H. H. Schierup, and H. Brix.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 65-72, 1990. 2 fig, 3 tab, 14 ref.

Descriptors: *Artificial wetland treatment, *Biological wastewater treatment, *Denmark, *Land treatment, *Wastewater treatment facilities, Biochemical oxygen demand, Effluent quality, Emergent hydrophyte treatment systems, Hydraulic conductivity, Reed bed treatment systems, Hydraulic lo.

Since 1983 approximately 150 full-scale emergent hydrophyte based wastewater treatment plants (reed beds) have been constructed in Denmark to serve small wastewater producers. The development of purification performance for 21 plants representing different soil types, vegetation, and hydraulic loading rates has been recorded. Cleaning efficiencies were typically in the range of 60-80% reduction for biochemical oxygen demand (BOD), 25-50% reduction for total nitrogen, and 20-40% reduction for total phosphorus. The mean effluent BOD, total nitrogen and total phosphorous concentrations of the reed beds were 19 plus or minus 10, 22 plus or minus 9 and 6.7 plus or minus 3.2 mg/L (mean plus or minus standard deviation), respectively. Thus, the general Danish effluent standards of 8 mg/L for nitrogen and 1.5 mg/L for phosphorous for sewage plants greater than 5000 population equivalents cannot be met by the present realized design of EHTS. The main problem observed in most systems is a poor development of horizontal hydraulic conductivity in the soil which results in surface run-off. Since the political demands for effluent quality will be more strict in the future, it is important to improve the performance of small decentral sewage treatment plants. On the basis of experiences from different types of macrophyte based and conventional low-technology wastewater treatment systems, a multistage system is suggested, consisting of sediment and sand filtration facilities followed by basins planted with emergent and submergent species of macrophytes and algal ponds. (Author's abstract)
W90-07779

DESIGN AND OPERATION OF WASTE STABILIZATION PONDS IN TOURIST AREAS OF MEDITERRANEAN EUROPE.
Leeds Univ. (England). Dept. of Civil Engineering.
D. D. Mara, and M. H. F. Marecos do Monte.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 73-76, 1990. 1 tab, 12 ref.

Descriptors: *Biological wastewater treatment, *Recreation facilities, *Stabilization ponds, *Wastewater treatment, Anaerobic ponds, Europe, Maturation ponds.

Waste stabilization ponds are now a well established treatment process for domestic wastewaters in Europe. There are nearly 2000 pond systems in France and around 1000 in West Germany, most of which serve small rural communities of less than 1000 people. In southern France and Portugal pond systems are, however used for larger communities and several are designed to treat the wastewaters from tourist resorts. Ponds are well suited to the treatment of such seasonal wastewater flows, especially in areas where the peak tourist season coincides with the hottest period of the year. For pond design in tourist areas, the wastewater flow and biochemical oxygen demand five (BOD5) in both winter and summer must be established. For winter conditions the resident population will generally have a wastewater flow of 80-150 liters per caput per day and a BOD5 contribution of 35-50 grams per caput per day. The summer design population should generally be taken as the mean, rather than the peak, value as the peak is usually only for 1-2 weeks; but the local pattern of tourist influx should be used to determine the appropriate design figure. The design temperature in winter is taken as the mean temperature of the coldest month (that is , the monthly mean of the means of the daily maximum and minimum temperatures). The summer design temperature should be taken as 3 deg C less than the mean temperature of the coolest month in the period used to determine the summer design flow. Anaerobic ponds which receive the conservative loadings recommended and which are located at least 200 m away from the edge of the tourist resort, do not give rise to an odor nuisance. The size and number of maturation ponds is determined by the required quality of the final effluent, and this in turn depends on what is to be done with it: discharge to coastal waters or an inland waterway, or for crop or greenspace irrigation. the operational requirements of ponds in tourist areas are, in principle, no different than those generally required for ponds. (Agostine-PTT)
W90-07780

SLUDGE ACCUMULATION IN AERATED FACULTATIVE LAGOONS OPERATING IN COLDER CLIMATE.
Sherbrooke Univ. (Quebec). Dept. of Civil Engineering.
K. S. Narasiah, M. Marin, and J. Shoiry.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 77-82, 1990. 1 fig, 2 tab, 6 ref.

Descriptors: *Aerated lagoons, *Biological wastewater treatment, *Quebec, *Sludge, *Wastewater treatment, Cold regions.

Notwithstanding the long time of retention and aeration in aerated facultative lagoons, not all the organic matter is oxidized to final products. Consequently there is significant accumulation of sludge in the lagoons which should be removed periodically so as not to interfere with the mixing and overall performance of the treatment system. Recent studies confirm that sludge accumulation is more pronounced in areas where water temperatures are lower than normal. Existing mathematical models for estimating sludge accumulation are found to either under or over estimate the actual quantities produced. This might be due to various constraints of each model like hydraulic retention time, type of aeration, coagulation usage and, of course, wastewater characteristics. In the present study, on-site measurements of sludge accumulation were conducted in aerated lagoons operating in small municipalities in Quebec. The results obtained are compared with those calculated using currently well known models. Corrections are proposed to the existing models so that future estimates can be more accurate than at present. (Author's abstract)
W90-07781

TECHNOLOGY ASSESSMENT OF WASTEWATER TREATMENT BY SOIL INFILTRATION SYSTEMS.
Norges Landbrukshoegskole, Aas. Inst. for Georesources and Pollution Research.
P. D. Jenssen, and R. L. Siegrist.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 83-92, 1990. 3 fig, 2 tab, 54 ref.

Descriptors: *Biological wastewater treatment, *Induced infiltration, *On-site wastewater treatment, *Soil filters, *Soil treatment, *Wastewater treatment, Norway, Subsurface wastewater infiltration.

Infiltration of wastewater in buried soil infiltration systems has been promoted as a low cost, effective alternative for treatment and disposal of wastewater flows from commercial developments and small communities. Unlike many mechanical wastewater treatment systems, soil infiltration systems are subject to complex, far-reaching influences related to natural site conditions and the interaction if wastewater with a dynamic soil and groundwater system. As a result, design and performance relationships are not always well defined and systems are often implemented based on local tradition and empiricism. Consequently there is a need for improvement of design criteria especially for large subsurface wastewater treatment systems. Successful performance starts with thorough site investigations, where large scale infiltration tests or tracer studies might be needed. The hydraulic loading rate is a principal design parameter. An integrated approach for assessment of the hydraulic loading rate based on the soil type and

wastewater quality is suggested. In general, trench design should be preferred over beds, but rational criteria for selection of optimal geometry is lacking. Purification performance of subsurface wastewater infiltration systems is generally good. Estimates of purification on the basis of soil grain size, soil depth and loading rate can be given. (Author's abstract)
W90-07782

ON-SITE WASTEWATER TREATMENT WITH INTERMITTENT BURIED FILTERS.
SYMBO, Liestal (Switzerland).
P. Schudel, and M. Boller.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 93-100, 1990. 11 fig, 2 tab, 5 ref.

Descriptors: *Biological wastewater treatment, *On-site wastewater treatment, *Wastewater treatment, Biological fixed beds, Hydraulic behavior, Intermittent filters, Nitrification, Switzerland, Tracers.

A few intermittent buried sand filters have been constructed in Switzerland for the on-site treatment of small wastewater sources. Intermittent buried filters offer several advantages for the treatment of small wastewater sources. if designed properly, they show excellent performance, requiring hardly any maintenance, and even allow the cultivation of the overlaying soil layer to a certain extent. Tracer experiments clearly indicate that with the usually used filter media of 1-4 mm, an effective size of 0.4-1 mm and a layer thickness of 0.7-1.0 m, the amount of wastewater discharged within one hour after a hydraulic flush equals about 80% of the dosing volume. The instantaneous hydraulic load of one dosing interval plays an important role concerning unsaturated flow and concurrent removal of pollutants in the filter media. The tracer Uranin is washed out over the period of several intervals. After two intervals of 6 hours each, 75% of the tracer is washed out at a hydraulic dose of 20 L/sq m, interval and 45% at a dose of 10 L/sq m, interval. Consequently, flushes of 10 L/sq m, interval revealed a satisfactory removal efficiency whereas 20 L/sq m, interval led to partial break-through along the hydraulic peak discharge. The ripening of buried sand filters to their maximum removal capacity is rather slow. It may take on the order of six months for full organics removal. Even longer periods may be required to achieve full nitrification. (Author's abstract)
W90-07783

EFFECT OF BIOLOGICAL CLOGGING ON IN-FILTRATION RATE IN SOIL TREATMENT SYSTEMS.
Tokyo Univ. (Japan). Inst. of Industrial Science.
T. Kawanishi, H. Kawashima, K. Chihara, and M. Suzuki.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 101-108, 1990. 7 fig, 1 tab, 3 ref.

Descriptors: *Biological wastewater treatment, *Infiltration rate, *Soil treatment, *Wastewater treatment, Biomass, Clogging, Gray water, Hydraulic conductivity, Permeation rate.

Effect of biomass on the soil hydraulic conductivity was clarified on andosol soil. The maximum allowable density of biomass in andosol appeared to be 16-30 mg/cu cm and the corresponding minimum hydraulic conductivity was about 0.2 microns sec. Hydraulic conductivity decreases exponentially as biomass density increases. The allowable feed rate will be in the range of 0.01-0.05 cubic m/m-trench day for the andosol. A numerical model was constructed, and the biomass growth and the change of permeability were simulated. By using the model, the permeation rate of a trench was predicted, and the predicted result was in good agreement with the experimental one. It indicates that the method developed here will be valid for the approximate estimation of the allowable wastewater feed rate of the site. (Agostine-PTT)
W90-07784

SOIL ABSORPTION SYSTEMS AND NITROGEN REMOVAL.
Centre Scientifique et Technique du Batiment, Marne la Vallee (France). Div. Evacuation et Traitment des Fluides et Dechets.
C. Cochet, D. Derangere, and T. Rousselle.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 109-116, 1990. 4 fig, 5 tab, 23 ref.

Descriptors: *Biological wastewater treatment, *Nitrogen removal, *On-site wastewater treatment, *Soil treatment, *Wastewater treatment, Denitrification, France, Groundwater, Nitrification, Sand filters, Subsurface infiltration.

The mass of nitrogen wasted from conventional soil absorption systems used as waste water drainage and treatment facilities sometimes contributes to pollution of vulnerable groundwater tables. The scope of nitrogen compounds transformation along the different stages of treatment shows that nitrate is quite often the nitrogen end product of efficient aerobic soil treatment for septic tank effluent. Reducing effluent nitrate concentration in subsurface soil absorption systems effluent is necessary where groundwater appears to be highly vulnerable, and when it is used as a water resource for human consumption. Results of the on-site study on a sand-textile flocks filter, indicates that a high degree of nitrification can be reached even for an hydraulic load in excess of those used for conventional systems. An induced clogging of the filtering media has been obtained by increasing hydraulic load up to 40 cm/day, and it was stated that nitrogen compound transformation into nitrate was quickly affected, while carbonic matter removal decreased drastically. Column studies conducted with synthetic effluent, produce encouraging results concerning denitrification efficiency on sand media, when an extra carbon source is added. It is shown that for a C/N ratio of 4/1 and an hydraulic load of 15 cm/day, nitrate removal can easily reach around 95% for most of the time, during a 5 month investigation period. (Author's abstract)
W90-07785

MODIFICATION OF SMALL ACTIVATED SLUDGE PLANTS TO RECYCLED SYSTEMS FOR NITROGEN REMOVAL AND CONTROL OF SETTLING PROPERTIES.
Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
A. Brenner.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 117-122, 1990. 3 fig, 2 tab, 13 ref.

Descriptors: *Activated sludge, *Biological wastewater treatment, *Wastewater treatment, Aeration, Bulking sludge, Chemical oxygen demand, Filamentous bulking, Israel, Nitrogen removal, Recycling.

Modification of small activated sludge plants to recycled systems is proposed as a means to improve nitrogen removal and control of settling properties. The modification process involves separation of the aeration basin to anoxic zones and addition of internal recycle of mixed liquor from the aerobic to the anoxic zone. This mode of operation may prevent problems of floating sludge in the final clarifier caused by uncontrolled denitrification. In the recycled system, part of the organic carbon is removed under anoxic conditions. Therefore, it may assist in the selection of microbial population with better settling characteristics, since most filamentous microbes have been reported to lack denitrifying ability. The modification considerations and guidelines are discussed based on experimental results obtained from operation of bench-scale recycled units. These results coupled with settling experiments suggest that bulking problems may be eliminated by regulating carbon removal by denitrification, using the process modification. As the fraction of chemical oxygen demand (COD) which is removed under anoxic conditions is increased, the growth of filamentous organisms is suppressed and the settling may be improved. Influent COD/ammonia ratio, aerobic volume fraction, and recycle rate are shown to be critical parameters in the modification and operation of such systems. (Author's abstract)
W90-07786

OPTIMIZATION OF NITROGEN REMOVAL IN SMALL ACTIVATED SLUDGE PLANTS.
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Antony (France).
A. Heduit, P. Duchene, and L. Sintes.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 123-130, 1990. 4 fig, 5 tab, 6 ref, 2 append.

Descriptors: *Activated sludge, *Biological wastewater treatment, *Nitrogen removal, *Wastewater treatment, Aeration basin, Denitrification, France.

In France, many small sewage treatment plants are of the activated sludge/extended aeration type and, generally, receive only a part of their nominal organic load. Most are equipped with surface aerators whose Standard Wire Aeration Efficiency is in the range 1.3-1.9 kg O2 kW/h. Consequently the sludge age and the supply of oxygen are sufficient to eliminate nitrogen from domestic wastewater even at a low sludge temperature. In order to optimize nitrogen treatment by the denitrification of ammonia in the aeration basin while avoiding any parasitic denitrification in the clarifier, 4 small domestic wastewater treatment plants were studied over several months. In order to optimize the elimination of nitrogen the following modifications were made: final concentrations of N-NH4(+) < 5 mg/L and N-NO3(-) < 3 mg/L. The daily operating time of the aerators depends on the load received, the sludge concentration and the oxygenation capacity. When the works are under-loaded, the non-operational periods of the aerators should be as long as 1.5 and 2 hours in order to achieve the nitrates reduction. When the load is higher, the time required to attain anoxia after the shutdown of the aerators is shorter and the length of the non-operational periods can be reduced. These field experiments have allowed an evaluation of the tolerances around an optimum adjustment of the aeration operation: a reduction of 5 to 10% of the daily aeration may increase the residual concentration of Kjeldahl nitrogen to 10 mg/L. Conversely, sludge losses may take place in the clarifiers if the daily aeration time is increased by 5 to 10% in the case of completely mixed basins equipped with slow vertical shaft aerators, and more than 15% in the case of oxidation ditches (better denitrification probably due to the concentration of the current after stopping the rotors). The sludge concentration should be kept within fairly tight limits (+or-0.5 g/L). It is however essential to rectify the aeration adjustments during the seasons: a rise in the sludge temperature of 10 degrees generates an increase in the total oxygen demand by 3 to 5%. (Author's abstract)
W90-07787

INTERMITTENT AERATION FOR NITROGEN REMOVAL IN SMALL OXIDATION DITCHES.
Saga Univ. (Japan). Dept. of Civil Engineering.
H. Araki, K. Koga, K. Inomae, T. Kusuda, and Y. Awaya.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 131-138, 1990. 9 fig, 1 tab, 8 ref.

Descriptors: *Biological wastewater treatment, *Intermittent aeration, *Nitrogen removal, *Wastewater treatment, Oxidation ditches, Single sludge systems.

An intermittent aeration method is available for nitrogen removal in a small oxidation ditch. The purpose of this study is to establish a basis for design and operation of the oxidation ditch with the intermittent aeration method. Discussions on the essential process parameters depending on cycle time, aerobic period, specific nitrification rate, and specific denitrification rate were carried out by using a continuous-flow stirred-tank model. It is shown theoretically that an optimum range of the aerobic time ratio for nitrogen removal exists in the region of 1/(specific nitrification rate) to 1-1/(specific denitrification rate). From evaluating an amount of leaking nitrogen in the intermittent aeration, the cycle time is proved to be minimized. Experiments in a full scale test plant were conducted to affirm the validity of the proposed basis. It is

confirmed that the total nitrogen removal efficiency of 90% is achieved and the estimated removal efficiencies by this basis agree well with the experimental data. The newly proposed basis and parameters for nitrogen removal using the intermittent aeration method are available for not only an oxidation ditch but also other nitrogen removal processes by single sludge systems. (Author's abstract)
W90-07788

DESIGN AND OPERATION OF SMALL WASTEWATER TREATMENT PLANTS BY THE MICROBIAL FILM PROCESS.
Kyoto Univ. (Japan).
S. Iwai, Y. Oshino, and T. Tsukada.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 139-144, 1990. 10 fig, 5 tab, 2 ref.

Descriptors: *Biofilms, *Biological wastewater treatment, *Japan, *Wastewater treatment, Biofilm reactors, Denitrification, Nitrogen removal, Phosphorus removal, Seasonal loading, Sludge.

Although the ratio of sewer systems to population in Japan has been improving in recent years, the construction of sewer systems in small communities such as farming or fishing villages, etc. had lagged behind that of urban areas. However, construction of small-scale sewer systems in farming and fishing villages has been actively carried out in recent years. In fact it is mainly since World War II, that wastewater treatment facilities have been actively developed. However, at the end of 1987, the ratio of wastewater treatment to the population was only 39%. In addition to the construction of large scale sewer systems for communities with populations over 10,000, the government is actively promoting the construction of small scale treatment systems for communities with populations from 100 to 10,000. The submerged aerobic biofilm system has characteristics suited to the requirements of small treatment plants and is now widely used. Among the desirable characteristics are: capability for high load treatment, small amount of excess sludge, diversity in biota, no need for return sludge, and easy to systematize tanks. The report introduces the design, operation and maintenance of representative wastewater treatment plants in farming and fishing villages which incorporate denitrification and dephosphorization. (Author's abstract)
W90-07789

BIOFILTRATION AS A COMPACT TECHNIQUE FOR SMALL WASTEWATER TREATMENT PLANTS.
Omnium de Traitement et Valorisation, Maisons-Laffitte (France). Chemin de la Digue.
G. Desbos, F. Rogalla, J. Sibony, and M. M. Bourbigot.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 145-152, 1990. 11 fig, 1 tab 30 ref.

Descriptors: *Biofiltration, *Biological wastewater treatment, *Denitrification, *Nitrification, *Wastewater treatment, Biomass, Effluent filtration, France.

Biological aerated filters combine bacterial degradation of pollution by fixed biomass with physical filtration a single reactor. Removal rates become independent of clarification and sludge settleability limits, and concentration of biomass is increased. Nitrifiers attach to the media, allowing nitrogen removal without sludge age constraints. Several fullsize plants with the BIOCARBONE process for industrial and municipal wastewater treatment have established the compacity, ease of operation and high removal rates achievable with this advanced treatment system. A new biofilter design offering simplified operation and increased performance is presented, which allows implementation of biofiltration for small wastewater treatment plants. Design data for carbon and nutrient removal were collected during extensive pilot tests. Hydraulic conditions and pollution loadings were varied in order to optimize the biological and operational parameters of the filter. The combination of an anaerobic and an aerobic zone eliminates the need for primary sedimentation. Pollution removal rates up to 20 kg chemical oxygen demand

per cubic meter per day could be achieved, and a widely fluctuating load of up to twice that average loading can be treated without major effluent deterioration. If lower carbon loadings are used, nitrification is achieved in the upper aerated zone. By recirculating the effluent into the non-aerated zone, carbon and ammonia oxidation as well as denitrification and suspended solids retention could be achieved with an overall hydraulic retention time of four hours in one reactor. (Author's abstract)
W90-07790

INFLUENCE OF DAILY VARIATION OF FLOW AND POLLUTION LOAD ON THE PERFORMANCE OF SUBMERGED ANAEROBIC/AEROBIC BIOFILM SYSTEM.
Tokyo Univ. of Agriculture and Technology (Japan). Dept. of Chemical Engineering.
T. Okubo, M. Okada, A. Murakami, and Y. Inamori.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 153-160, 1990. 6 fig, 15 ref.

Descriptors: *Biofilms, *Biological wastewater treatment, *Dissolved organic carbon, *Pollution load, *Wastewater treatment, Filters, Gray water, Hydraulic retention time, Japan, Mathematical models.

Effects of daily variation of flow on the performance of submerged anaerobic/aerobic biofilm systems were investigated both by laboratory study using synthetic wastewater and by field study using gray water. In the laboratory study, concentration of dissolved organic carbon (DOC) in effluent from anaerobic filters fluctuated with daily variation of flow when the average hydraulic retention time (HRT) was below 10 h. However, daily mean values of DOC under the varied flow was almost the same as those under constant flow within the same daily mean HRT. Aerobic filter linked to anaerobic filter reduced the concentration of DOC satisfactorily though the concentration in anaerobic filter increased under short HTR. In field study, percent removal of organic carbon by anaerobic filter was considerably smaller (20-30%) than that in laboratory study (90-95%) both at HRT of 20 h though it was improved up to 60-80% by aerobic filter. Effects of peaking factor hardly affected daily mean values of DOC within the same daily mean HRT though maximum values of DOC increased with the increase of peaking factor. (Author's abstract)
W90-07791

ENLARGEMENT OF SEWAGE TREATMENT PLANTS FOR NITRIFICATION BY USE OF SUBSEQUENT ROTATING BIOLOGICAL CONTACTORS.
Mecana Umwelttechnik A.G., Schmerikon (Switzerland).
G. Nyhuis.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 161-168, 1990. 7 fig, 4 tab, 3 ref.

Descriptors: *Biological wastewater treatment, *Nitrification, *Wastewater treatment, Contactors, Filtration, Oxidation ponds, Sludge, Switzerland.

The surface-specific nitrification performance of Rotating Biological Contactors (RBC) has been improved considerably by the use of new techniques. Maximum nitrification rates of 3.3 g/sq/mxd (10 C) were achieved, which cannot be approached with any other known procedure. This high oxidation efficiency is achieved with RBCs by using two new measures: (1) A large degree of separation of carbon degradation and nitrogen oxidation through filtration of the waste water before the subsequent nitrifying RBC stage, whereby the environmental conditions for the nitrifying bacteria are improved, especially in respect of an optimized supply of oxygen. (2) Periodic reversal of the direction of flow in the RBC stage which is constructed as a cascade. This measure allows the attainment of a uniform thickness of nitrifying bacteria growth in all the compartments, which has a particularly advantageous effect in the case of unavoidable surges in load. Because of the low production of excess sludge in the nitrification stage, a

subsequent stage for separating solids is not necessary. The new techniques which have been introduced have led to a considerable increase in the performance of a subsequent RBC. With this the disadvantage of comparatively high investment for this process is decisively mitigated, and the process-specific advantages, such as extremely low energy consumption and high process stability come to the fore. Today the task frequently arises of extending the objective of an existing plant to nitrification. The procedure investigated here is an interesting alternative for just this application, in that no intrusion into the existing civil work structure is necessary. the space requirement for the extension is very small, and the operation of the plant can be maintained unchanged during the construction phase. (Author's abstract)
W90-07792

NITRIFICATION KINETICS AND SIMULTANEOUS REMOVAL OF BIOMASS AND PHOSPHOROUS IN ROTATING BIOLOGICAL CONTACTORS.
Miyazaki Univ. (Japan). Dept. of Civil Engineering.
Y. Watanabe, C. Lee, M. Koike, and M. Ishiguro.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 169-178, 1990. 19 fig, 2 tab, 15 ref.

Descriptors: *Adsorption kinetics, *Biofilms, *Biological wastewater treatment, *Contactors, *Wastewater treatment, Biomass, External diffusion, Japan, Nitrification, Phosphorus.

Some important aspects of the Rotating Biological Contactor (RBC) are disucssed. Steady-state biofilm kinetics was applicated to the design of an RBC aiming at nitrification using the proposed kinetics in which the flux of rate-limiting substrate is expressed as a function of the bulk substrate concentration, liquid boundary layer thickness, liquid film thickness, and molecular diffusion coefficient and intrinsic reaction rate of the substrate, the relationship between the bulk ammonia concentration and ammonia flux was predicted at various sizes and rotating speeds of disk. Experimental verification of the predicted results was also made. A new reticulated media with surface protrusions, was proposed to promote the external diffusion of soluble substrates to the biofilm, and to reduce the disk weight. Simultaneous removal of the detached biomass and precipitated phosphorous uses a two-story RBC whose upper and lower parts function as the RBC trough and storage space of the detached biomass, operated in a four-staged unit. Experimental investigation showed that the phosphorous precipitated by aluminum was adsorbed to the biofilm, and settled into the lower part as the detached biomass. The removal efficiency of the detached biomass was very high resulting in an effluent suspended solids concentration of about 10 ppm. (Author's abstract)
W90-07793

ORGANIC CARBON AND NITROGEN REMOVAL IN ATTACHED-GROWTH CIRCULATING REACTOR (ACGR).
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Karnchanawong, and C. Polprasert.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 179-186, 1990. 4 fig, 5 tab, 5 ref.

Descriptors: *Biofilms, *Biological wastewater treatment, *Nitrogen removal, *Organic carbon, *Wastewater treatment, Attached-growth reactors, Thailand.

Experiments on attached-growth circulating reactor (AGCR) were conducted to investigate its efficiencies on organic carbon and nitrogen removal (through denitrification). A laboratory scale AGCR, made of serpentine channel with a total length of 180.0 m, was fed with a synthetic wastewater at the chemical oxygen demand (COD) and total nitrogen (TN) loading rates of 3.56-10.16 and 0.30-0.91 g/(sq m.d), respectively. The reactor effluent was recycled back to the influent feeding point and the dissolved oxygen (DO) concentrations along the channel length

were controlled by means of air diffusion. It was found that the COD loading rate of 5 g/(sq m/d), corresponding to the TN loading rate of 0.54 g/(sq m/d) gave optimal COD and TN removal rates of 4.8 and 0.43 g/(sq m/d), respectively. The overall AGCR performance was limited by the nitrification efficiency at the high TN loading rates. The biofilm accumulation and thickness were found to be relatively high in the first-half portion of the channel length where carbon oxidation and denitrification were predominant. The second-half portion where nitrification mainly occurred had much less biofilm accumulation and thickness. (Author's abstract)
W90-07794

SUITABILITY OF DIFFERENT BIOLOGICAL SEWAGE TREATMENT SYSTEMS.
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
K. Bucksteeg.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 187-194, 1990. 8 fig, 1 tab, 9 ref, append.

Descriptors: *Activated sludge, *Biological wastewater treatment, *Contactors, *Wastewater treatment, Aerated ponds, Artificial wetland treatment, Biological filters, Emergent hydrophyte treatment systems, Trickling filters.

Small wastewater treatment plants suffer from higher specific peak loads and less qualified operational services. Therefore, small plants need special rules for design, construction and operation. Technical plants are used preferably for serving housing estates, especially when separate sewerages exist. Among those in use are activated sludge plants, trickling filters, rotating bio-contactors and prefabricated plants. Activated sludge plants with long time aeration are suitable for all plant sizes. In general they are less costly in construction but have higher energy consumption compared to trickling or bio-filters. Trickling filters are characterized by very simple machinery, only pumps. When trickling filters are loaded very low, then high biochemical oxygen demand and chemical oxygen demand reduction as well as nitrification take place. With rotating bio-contactors, many alternative systems are offered, and are qualified similarly to trickling filters. Activated sludge plants with long time aeration are less stable and performance compared to trickling filters and rotating bio-contactors. Prefabricated plants are generally less costly in construction compared to individually constructed plants of the same technical system. However, they cannot be adapted as well to individual requirements and to special operation demands. Pond systems are a favorable solution for villages with combined sewerages, especially in rural areas. Non-artificially aerated ponds are applied for sewage treatment in rural villages where sufficient land and suitable underground are available. Artificially aerated ponds need much less area compared to the artificially aerated ponds. They are preferred for application when sewage of more than 1000 population equivalents or sewage of food industries has to be treated. Emergent hydrophyte treatment systems (EHTS) have been offered in recent years as an alternative to biological treatment. However, obligatory rules for dimensioning and construction as well as for operation are not available as yet. EHTS (reed beds) are considered as still being under development. Practice proves that newly developed, highly sophisticated technical systems tend toward simplification, and small reaction volumes or areas are increasing when applied under practical conditions. (Agostine-PTT)
W90-07795

ADVANCED CHEMICAL TREATMENT WITH FLOCCULATION IN PIPES.
National Board of Waters, Helsinki (Finland).
A. Latvala.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 195-202, 1990. 6 fig, 2 tab.

Descriptors: *Chemical treatment, *Wastewater treatment, Finland, Flocculation, Nitrogen removal, Sedimentation, Sludge.

At the beginning of 1988 there were about ten small chemical wastewater treatment plants in Finland that were using flocculation in pipes instead of flocculation basins. This method consists of Me(+3) chemical feeding, mixing, flocculation and sedimentation. Chemicals were fed into the suction openings of the wastewater pump, which is used for rapid mixing and also for pumping wastewater flow to the sedimentation basin. In the sedimentation sludge blanket sedimentation in deep vertical sedimentation basins was used. The sedimentation basin can also be used as sludge storage, if it is made sufficiently large. This method has been found especially suitable for small wastewater treatment plants, because it needs little labor and is cheap to build and use, and it is not affected negatively by fluctuations in the flow. The construction costs of this system in Finland have been about 50% of those involved in traditional chemical package plants. The limitations of this method are its weakness in removing soluble organic load and its inability to oxygenate or remove nitrogen. However, a biological unit designed to cope with these limitations is under development. (Author's abstract)
W90-07796

PRIMARY CHEMICAL TREATMENT MINIMIZING DEPENDENCE ON BIOPROCESS IN SMALL TREATMENT PLANTS.
Technion - Israel Inst. of Tech., Haifa. Sherman Center for Research in Environmental and Water Resources Engineering.
N. Galil, and M. Rebhun.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 203-210, 1990. 7 fig, 4 tab, 10 ref.

Descriptors: *Activated sludge, *Chemical treatment, *Israel, *Kinetics, *Wastewater treatment, Biological treatment, Flocculation.

In wastewater from small communities, institutions, hotels, camps and tourist areas the major pollutants such as organic matter, oil and grease and organic nitrogen are low. This is due to the short residence times in the sewerage systems preventing decomposition and lysis. Such wastewaters are also characterized by high variations in pollution load, mostly in the particulate fraction. Small plants, treating wastewater for discharge to lakes or rivers, have to remove organic pollutants and nutrients, mainly phosphorus. Chemical flocculation-sedimentation, as primary treatment, was considered a promising process combination to obtain reliable operation and for minimizing effects of variations in flow and load. Two possible process combinations were studied: (a) chemical flocculation-sedimentation as a primary stage, followed by biotreatment (CBT); (b) biotreatment of raw wastewater, followed by chemical flocculation-sedimentation (BCT). It was found that primary chemical treatment by alum, or lime, removes more than 90 percent of the suspended solids, colloids, phosphates, oil and grease; the organic matter as biochemical oxygen demand and organic nitrogen removals were about 70 percent. By removing the particulate organic matter and other disturbing factors the successive bioprocess in CBT was substantially improved: the growth rate constants for general biomass and for nitrifiers as well as the removal rates were higher for CBT than for BCT; the critical sludge age for nitrification in CBT was 4 days, as compared to 10 days in BCT. The reduction of organic load by about 70 percent, producing a more uniform influent and the better biokinetics achieved in CBT, enable a considerable economy in the bioreactor volume and lower energy requirement. Experimental results showed that the CBT sequence enables lower sludge production containing higher concentrations of solids, most of them inorganic. (Author's abstract)
W90-07797

NUTRIENT REMOVAL IN SMALL WASTEWATER TREATMENT PLANTS.
Krouger (I.) A/S, Soeborg (Denmark).
N. S. Olesen.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 211-216, 1990. 7 fig,1 tab, 5 ref.

Descriptors: *Biological wastewater treatment, *Nitrogen removal, *Wastewater treatment, Denmark, Ferrous sulfate, Oxidation ditches, Phosphorus removal, Recirculation.

In some areas of Denmark nutrient removal is required even for very small wastewater plants, that is, down to 500 person equivalents (pe). The goal is 80 percent removal of nitrogen and 90 percent removal of phosphorus, or in terms of concentrations: 8 mg nitrogen/L and 1.2 mg phosphorus/L. The inlet concentrations are typically 40 mg N/L and 10 mg P/L. The paper presents the results from two such plants with a capacity of 800 pe. Phosphorus removal is made by simultaneous precipitation with ferrous sulfate. Nitrogen removal is carried out using the recirculation method. Both plants were originally rotor aerated oxidation ditches. They have been extended with a denitrification reactor and a recirculation pumping station. At present both plants have been in activity for about three years and with satisfactory results. Average concentrations of nitrogen (summer) and phosphorus is 7 mg/L and 0.9 mg/L respectively. Nitrogen removal seems to be an practical solution on these small plants. It is, though, sensitive to temperature and highly oxidized rain water. Phosphorus removal seems to be an easily run and relatively non-sensitive technique at least when using simultaneous precipitation. (Author's abstract)
W90-07798

ZERO DISCHARGE THROUGH INNOVATIVE APPLICATION OF INTENSIVE SILVICULTURE TO EFFLUENT DISPOSAL FROM A SMALL CANADIAN WASTEWATER TREATMENT PLANT.
Anderson (R.V.) Associates Ltd., Willowdale (Ontario).
P. J. Laughton, C. S. Papadopol, and P. Jaciw.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 217-224, 1990. 4 fig, 3 tab, 11 ref.

Descriptors: *Biological wastewater treatment, *Effluents, *Land treatment, *Wastewater treatment, Canada, Evapotranspiration, Groundwater, Irrigation, Poplar trees, Silviculture.

The disposal wastewater from remote rural communities can be accomplished by means of land application utilizing leaching beds of various designs. In certain situations this method may not be suitable and alternate solutions must be found, especially where there is a mandated requirement for a zero effluent discharge and a desire to reduce the potential for infiltration of effluent residuals into the groundwater. The application of intensive silviculture for the disposal of treated effluent offers such an alternative. The King City, Ontario facility is described as follows. Raw sewage is treated in two small activated sludge plants with a total design capacity of 272 cubic m/d. The plants incorporate: comminution, coarse bubble diffused aeration, final settling and hypochlorite disinfection prior to discharging to an effluent (holding) pond. All sludge is digested aerobically prior to offsite disposal. In order to assure aerobic conditions in the pond at all times, a 'tube type' aeration system positioned along the floor bottom provides a small amount of air. The irrigation system is an in-ground facility with the effluent sprayed through a series of rotating sprinklers. Secondary treated effluent was seasonally applied to a forested plantation through an automated sprinkler system. For the past six years, significant growth rhythm differences were found among the poplar clones. The influence of effluent irrigation on growth, with its additional nutrient content, is positive but not as yet deemed significant. Work to date would suggest that evapotranspiration of effluent by the plantation can be 3-4 times greater as compared to grass. This is attributed to increased foliage, larger direct evaporation and advection. Since the structure of plantation can be manipulated to a certain extent, it is speculated that further increases of evapotranspiration can be obtained even in a sub-humid climate. The concept could be applied in various geographic areas with existing technology and software allowing for the complete

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automation of an effluent recycling system. (Agostine-PTT)
W90-07799

THERMOPHILIC AEROBIC DIGESTION--A RELIABLE AND EFFECTIVE PROCESS FOR SLUDGE TREATMENT AT SMALL WORKS.
Water Research Centre, Stevenage (England).
K. C. Murray, A. Tong, and A. M. Bruce.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 225-232, 1990. 3 fig, 6 tab, 4 ref.

Descriptors: *Biological wastewater treatment, *Sludge treatment, *Wastewater treatment, Aerobic digestion, Disinfection, England, Thermophilic digestion.

In January 1987 a thermophilic aerobic digestion (TAD) plant was installed at Haltwhistle sewage treatment works to assess its suitability for sludge treatment at small isolated sewage works. TAD was found to be a reliable,simple-to-operate, sludge treatment method suitable for small isolated works. It can be operated batchwise or semi-continuously according to the sludge load. Digester temperatures above 55 C can be obtained even during the winter months provided the digester is well insulated. TAD plants have low maintenance requirements, the only moving parts being the recirculating pump and foam cutter. Screening or comminution of the raw sludge is necessary prior to digestion. Grit removal is an advantage. The treated sludge is less odorous than raw sludge, easily spread on land, of high available nitrogen content,and easily consolidated, which reduces disposal costs. Experience at Haltwhistle has shown that TAD is an effective method of sludge stabilization and disinfection. Permanent TAD plants are now being installed at two sites in the Northumbrian Water Authority area. (Agostine-PTT)
W90-07800

SLUDGE HANDLING AND DISPOSAL AT SMALL WASTEWATER TREATMENT PLANTS IN NORWAY.
Aquateam-Norwegian Water Technology Centre of Oslo (Norway).
B. Paulsrud.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 233-238, 1990. 3 fig, 2 tab, 11 ref.

Descriptors: *Aerobic digestion, *Biological wastewater treatment, *Lagoons, *Norway, *Sludge drying, *Sludge treatment, *Wastewater treatment.

Most sludges from small wastewater treatment plants in Norway are either dumped in sanitary landfills or utilized on agricultural land. Norwegian guidelines for wastewater sludge disposal recommend all sludges to be dewatered prior to disposal. For agricultural use the sludge should be stabilized at the treatment plant or stored in piles for at least six months before utilization. Almost every plant has possibilities for sludge gravity thickening, and polymer addition is becoming quite popular for that process. Dewatering of sludge will often take place at a larger treatment plant, or in areas with no such plants, dewatering lagoons and mobile dewatering trucks are employed. For sludge stabilization, aerobic digestion is the predominant method. (Author's abstract)
W90-07801

DEWATERING OF SLUDGE BY NATURAL METHODS.
Lulea Univ. (Sweden). Div. of Sanitary Engineering.
S. Marklund.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 239-246, 1990. 7 fig, 8 ref.

Descriptors: *Biological wastewater treatment, *Sludge treatment, *Wastewater treatment, Dewatering, Evaporation, Sludge drying, Sweden.

Drying from a free water surface and from a waste activated sludge was studied in three separate experimental arrangements. Evaporation in a closed chamber with a surface area of 1.0 sq m was studied with temperatures between 20 and 60 C and air flows between 75 and 300 cu m/hr. The rate of evaporation varied between 351 and 746 g/sq m-hour. The efficiency varied between 11 and 20%. To increase the efficiency the air-liquid area has to be enlarged. Evaporation from two pilot sludge drying beds was studied in an open air test lasting four months. One similar bed was tested in a controlled environment. The results showed that above a critical moisture content between 600 and 1100% evaporation from sludge equals the rate of evaporation from a free water surface. Below the critical moisture level the rate decreases rapidly. Further work should be directed towards full-scale tests with covered drying beds. Special attention should be drawn to methods to improve the drying rate during the falling rate period, to two phase drying and to the evaluation of a combined dewatering system with sludge freeze drying in winter season and sludge drying in summer season. (Author's abstract)
W90-07802

SLUDGE REMOVAL FROM SOME WASTEWATER STABILIZATION PONDS.
Ecole Nationale de la Sante Publique, Rennes (France). Lab. de Genie Sanitaire.
J. Carre, M. P. Laigre, and M. Legeas.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 247-252, 1990. 3 fig, 2 tab,7 ref.

Descriptors: *Biological wastewater treatment, *Stabilization ponds, *Wastewater treatment, Costs, France, Sludge disposal.

The study of sludge accumulation in the first ponds of 12 treatment plants under oceanic climate showed a mean rate of accumulation of 2.8 cm per year corresponding to 0.12 cubic meter of sludge per inhabitant per year. Desludging was required about operation periods of 6 or 7 years. Sludge removal by pumping after or without emptying water is the most convenient and with a mean cost of 40 Francs per cubic meter, the cheapest method. Mean desludging cost is eight times lower than mean investment cost. With regard to their agronomic characteristics, stabilization pond sludges have a low fertilizer value because of their long maturation time. (Author's abstract)
W90-07803

QUALITATIVE AND QUANTITATIVE CHARACTERIZATION OF WASTE WATER FOR SMALL COMMUNITIES.
Centre National du Machinisme Agricole, du Genie Rural, des Eaux et des Forets, Lyon (France). Div. Qualite des Eaux.
R. Pujol, and A. Lienard.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 253-260, 1990. 1 fig, 6 tab, 4 ref.

Descriptors: *Biological oxygen demand, *Biological wastewater treatment, *Chemical oxygen demand, *Wastewater treatment, France, Plant design, Qualitative analysis, Quantitative analysis.

An understanding of the waste water nature, from both the qualitative and quantitative points of view, is a fundamental factor in the selection of treatment techniques and their subsequent operation. This is even more so in the case of small communities whose discharges are more subject to variation. An analysis of French data in this field provides values for small communities in rural areas (the majority). Three main points emerge from this qualitative and quantitative analysis of the waste water of small communities. (1) The volumes and concentrations of discharges depend on the way of life of the users, the level of equipment of the dwellings, and the hygiene habits. (2) The scale of variation in the flow of pollutants varies inversely with the size of the community. (3) The length and condition of the sewerage system (infiltration of clear water) have a direct effect on the volume of water collected and the water concentration. Small rural communities are a very important group for which the characteristics of waste water are known: the mean ratios correspond to 150 L/day and 32 g biochemical oxygen demand(BOD)/day per person-equivalent. Depending on the condition of the sewerage system,

the volume of water will be greater if it is well drained, but the volume will rarely fall below 80 L/day even for a short and really separated system. The mean figure of 32 BOD/day is less than the commonly accepted value for urban areas, in the future the increase in this ratio should be moderate. The cases studied demonstrate the importance of some factors affecting the pollution load discharged. (Agostine-PTT)
W90-07804

RAISING THE STANDARD OF OPERATION OF SMALL SEWAGE WORKS.
Thames Water Authority, Waltham Cross (England). Sewerage and Sewer Treatment.
J. L. Dakers, and A. G. Cockburn.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 261-266, 1990.

Descriptors: *Automation, *Biological wastewater treatment, *Design standards, *Thames River, *Wastewater treatment, Effluent standards, England, Headwaters, Project management, Telemetry.

Thames Water operates about 400 sewage works in the catchment area of the Thames River, over half of these serve populations of less than 2000. These small works are mainly biological filter works but also include oxidation ditches and reed beds. Most of these works discharge to the headwaters of salmonid rivers which are used as drinking water sources and therefore have to meet high standards including in many cases full nitrification and low suspended solids. The paper describes the consent standards set for the works. Currently a number of small works do not meet these standards, so Thames Water has committed itself to having all works operating within standards by 1992. There are a number of reasons for failure which include, overloading due to increase in population and water use, trade effluent discharges, and operational problems. Small works may also fail to meet their standards because they are unmanned apart from infrequent maintenance visits, and thus any plant failure may go unnoticed for some days. Thames Water is adopting a twofold strategy to overcome these problems. Firstly, so that operational problems may be identified quickly a simple, cost effective system of automation and telemetry is being installed and secondly, to overcome operational and facility deficiencies , a Project Management team has been set up to identify the causes of failure, to prioritize remedial work, to recommend alternative operational strategies, if appropriate, to design and build extensions or new works if appropriate, and if remedial works cannot be built quickly enough, to install a temporary plant to ensure compliance with effluent standards. (Author's abstract)
W90-07805

EXPERIENCE AND THE RESULTS OF OPERATING SMALL WASTEWATER TREATMENT PLANTS.
Ljubljana Univ. (Yugoslavia). Inst. za Zdravstveno Hidrotehniko.
M. Rismal.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 267-273, 1990. 9 fig, 3 tab, 3 ref.

Descriptors: *Biological wastewater treatment, *Chemical treatment, *Wastewater treatment, Activated sludge, Aeration tanks, Effluents, Oxygenation, Rotating discs, Yugoslavia.

Fifteen years of experience gained from operating 7 small wastewater treatment plants between 150-500 population equivalents (p.e.) and 6 plants of 2000-3000 p.e. capacity led to the following conclusions. Given safe equipment operation, properly designed small low-loaded activated sludge treatment plants give satisfactory results. Water jet aeration provides a good mixing efficiency also in deeper aeration tanks up to 6 meters in depth. In comparison with classical oxidation ditches, this makes it possible to reduce the required area of the plant. Measurements of flow velocities in deep tanks show even vertical distribution of velocities of over 0.3 m/s, even at the bottom of the aeration

tank (power input of about 10 W/cubic meter). Because the jet aeration method takes water from the bottom of the aeration tank, the operation of the plant (when compared with other surface aerators) is less affected by the ice cover at low temperatures. All of the plants involved are low-loaded activated sludge plants with water jet aeration generated by screw or propeller pumps which both proved to be efficient an aeration while secure and simple in operation. In comparison with other types of small treatment plants in our country (rotating discs and bubble aeration activated sludge plants), they proved to be reliable and simple in operation and produce an effluent of good quality. The energy consumption and the necessary flow velocities in aeration tanks are computed and measured. (Agostine-PTT)
W90-07806

PERFORMANCE STABILITY OF SMALL BIO-LOGICAL CHEMICAL TREATMENT PLANTS.
Aquateam-Norwegian Water Technology Centre of Oslo (Norway).
R. Storhaug.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 275-282, 1990. 3 fig, 4 tab, 5 ref.

Descriptors: *Activated sludge, *Biological wastewater treatment, *Chemical treatment, *Effluents, *Norway, *Wastewater treatment, Biological oxygen demand, Contactors, Flocculation, Water quality standards.

Biological and chemical treatment plants constitute a main portion of the overall number of treatment plants in Norway. The biological and chemical plants are divided into three process groups, simultaneous precipitation and activated sludge, combined precipitation and rotating biological contactors (RBC) and post precipitation and activated sludge. Aluminum sulfate or ferric chloride are commonly used flocculants in the chemical precipitation process. Effluent data from 174 Norwegian biological chemical treatment plants has shown that 50% of the plants meet the standard for phosphorus removal, 70% of the plants meet the standards for removal of organic matter (BOD7). Only 30% of the combined precipitation plants meet the standard for phosphorus removal and 60% meet the standard for removal of BOD7. Forty percent of the simultaneous precipitation plants meet the standard for phosphorus removal and 75% of the plants meet the standard for removal of BOD7. Compared to the effluent standards for each process group, post precipitation shows the best performance. On an average these plants have the lowest actual utilization of the design capacity. The most important factors that cause the treatment plants not to meet the effluent standards are, poor quality of the sewer systems, improper design of the plant and organizational problems. Satisfactory separation of particles, flow equalization and proper operational management, are the basic demands to achieve low effluent concentrations for total phosphorus and BOD7. (Author's abstract)
W90-07807

URBAN DRAINAGE STRATEGIES FOR SMALL COMMUNITIES IN DEVELOPING COUNTRIES.
Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.
M. Grottker, and A. Khelil.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 283-290, 1990. 3 fig, 5 tab.

Descriptors: *Biological wastewater treatment, *Developing countries, *Sewers, *Storm drains, *Urban drainage, *Wastewater treatment, Drainage standards, Sanitation.

Urban drainage systems have to fulfill both the safe removal of storm water and waste water. Most of the drainage and treatment techniques have been developed in highly industrialized countries. Unfortunately, in small communities in developing countries, only a few of these techniques are applicable. The standard of the urban drainage system is a main factor of the living standard. An insufficient

drainage standard directly influences basic needs of the human being, such as: plenty of drinking water, plenty of unpolluted food, health and hygiene, and housing. The drainage system has to prevent the spreading of potential diseases, the flooding of urban areas, and the drainage and treatment system should protect the receiving waters soil and groundwater from the pollution caused by the sewerage. Three different drainage systems can be built in small communities in developing countries: combined sewerage system, separate sewerage system and qualified separate sewerage system. In developing countries the characteristics of catchment areas differ very much from the ones in industrialized countries. Consequently, the plants have to be adapted to the local conditions of drainage, climate and location. An urban drainage strategy should be worked out to improve the drainage system of a small community in a developing country. Finally, the urban drainage strategy will give an idea how to sanitize drainage systems. (Agostine-PTT)
W90-07808

BOTTLENECKS IN THE IMPLEMENTATION OF ON-SITE WASTEWATER TREATMENT PLANTS ON A LARGE SCALE IN THE NETHERLANDS.
Witteveen and Bos, Deventer (Netherlands).
F. A. Fastenau, J. H. J. M. van der Graff, and G. Martijnse.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 291-198, 1990. 1 tab 3 ref.

Descriptors: *Biological wastewater treatment, *On-site wastewater treatment, *Political aspects, *The Netherlands, *Wastewater treatment, Organization management.

More then 90% of the total housing stock in the Netherlands is connected to central sewerage systems and in most cases the wastewater is treated biologically. As connection to central sewerage systems has reached its economic limits, interest in on-site treatment of the domestic wastewater of the remaining premises is increasing. A large scale research program into on-site treatment up to population equivalents of 200 persons has therefore been initiated by the Dutch Ministry of Housing, Physical Planning and Environment. Intensive field-research work did establish that the technological features of most on-site biological treatment systems were satisfactory. A large scale implementation of these systems is however obstructed in different extents by problems of an organizational, financial and/or juridical nature and management difficulties. At present research is carried out to identify these bottlenecks and to analyze possible solutions. Some preliminary results are given which involve the following 'bottlenecks': legislation (absence of coordination and absence of a definition of 'surface water'); absence of subsidies; ownership; inspection; operational control and maintenance; organization of management; discharge permits; pollution levy; and sludge disposal. Final decisions and practical elaboration of policies towards on-site treatment will have to be formulated in a broad discussion with all the authorities and interest groups involved. (Author's abstract)
W90-07809

TREATMENT OF OILY CAFETERIA WASTEWATER BY SINGLE-PHASE AND TWO-PHASE ANAEROBIC FILTER.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
K. Hanaki, T. Matsuo, and K. Kumazaki.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 200-306, 1990. 8 fig, 1 tab, 6 ref.

Descriptors: *Anaerobic filters, *Biological wastewater treatment, *Wastewater treatment, Chemical oxygen demand, Japan, Lipid degradation, Lipids, Oily water, Two-phase digestion.

Cafeteria wastewater containing about 30 % of lipid on chemical oxygen demand (COD) basis was treated at by a laboratory-scale anaerobic filter at 20 deg C in a single-phase system and two-phase systems. Stable COD removal (about 80%) was achieved in spite of large fluctuation in influent COD concentration (normal range of 1300-2500

mg/L) both in the single-phase system (hydraulic retention time (HRT) longer than 1.3 d) and in the two-phase system (HRT longer than 3.3 d). The single-phase system gave better effluent quality than the two-phase system because the single-phase entrapped suspended solids better than the two-phase. However, material in balance revealed that methane conversion from removed COD was higher in the two-phase system than the single-phase system. The single-phase perhaps removed lipids by entrapment with filter media without biodegradation, and this might cause clogging problems in long-term operation. The two phase-system is recommended since it degrades lipids better than the single-phase system. (Author's abstract)
W90-07810

LEACHATE TREATMENT: DESIGN RECOMMENDATION FOR SMALL BUT EXTREMELY FLUCTUATING, HIGHLY POLLUTED QUANTITIES OF WATER.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.
K. H. Hartmann, and E. Hoffmann.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 307-314, 1990. 7 fig,1 tab, 8 ref.

Descriptors: *Biological wastewater treatment, *Chemical wastewater treatment, *Design criteria, *Leachates, *Wastewater treatment, Biological contactors, Storage basin design, West Germany.

Today's practice in leachate treatment and disposal in the Federal Republic of Germany comprises two possibilities: (a) the combined leachate domestic wastewater treatment (transportation to the treatment plant either using the sewer system or tank trucks); (b) complete, decentralized treatment at the source of the leachate production. As a result of the updating of the general water management law, the discharge of waste waters containing dangerous substances into sewer systems is no longer permitted. As there is no possibility of a selective removal of the hazardous substances, the future consequence will be that the whole amount of the leachate has to be treated at the landfill site. Existing leachate treatment plants are often designed for average rates. Because of the high fluctuations of the leachate quantity such plants are often overloaded. In the past there were two solutions: (a) temporary transportation to a treatment plant using trucks; (b) recycling of the excess leachate volume. As transportation is no longer accepted there is only the possibility of recycling left. The feasibility of buffering the runoff peaks has not yet been studied in detail (reservoir management). This cost-favorable option (earth basin with sealing) offers two advantages. First, the plant design can be based on mean conditions while secondly the loading of the plant will be almost constant (no variation concerning the hydraulic loading; concentration equalization effect of the storage tank). Herewith an attractive way of adapting existing plants to the time dependent changing requirements is available. (Author's abstract)
W90-07811

PERFORMANCE OF A NEW EQUIPMENT FOR TREATING WASTEWATER.
Gunma Univ., Maebashi (Japan). Dept. of Civil Engineering.
M. Kuroda, Y. Sakakibara, T. Arai, A. Arai, and D. Shibayama.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 315-322, 1990. 7 fig, 3 tab, 1 ref.

Descriptors: *Biological wastewater treatment, *Wastewater treatment, Biochemical oxygen demand, Domestic wastewater, Fixed-bed aeration, Japan, Sludge.

A fixed-bed aeration reactor system was developed for on-site and small-scale wastewater treatment. The reactor was packed with horizontal plates as support materials. There was no clarifier in the system. Three operational regimes were tested, which were a 6 hours total cycle, 8 hours total cycle, and 12 hours total cycle. Experimental re-

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sults showed the reactor can treat household wastewater efficiently. Removal efficiencies of biochemical oxygen demand (BOD) loading rate of 0.12 kg-BOD/cu m-d or 5.2 g-BOD/ sq m-d. Effluent BOD and suspended solids (SS) concentrations were means of 18 mg/L and 6 mg/L during the whole time operation. Suspended solids efficiently sedimented on the horizontal support plates in a short settling time. Equations were developed to predict BOD consumption and sludge production as a function of influent soluble BOD and SS. Useful design and operating parameters are identified for future evaluations of the fixed bed aeration reactor. (Author's abstract)
W90-07812

INTERMITTENT CYCLE EXTENDED AERATION SYSTEM (ICEAS R) FOR SMALL WASTEWATER TREATMENT PLANTS.
Austgen Biojet Waste Water Systems, Inc., San Francisco, CA.
H. A. Khararjian, W. H. Callaway, P. Cardinal, and J. Meany.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 323-330, 1990. 4 fig, 3 tab, 7 ref.

Descriptors: *Aerobic treatment, *Biological wastewater treatment, *Denitrification, *Nitrification, *Wastewater treatment, California, Phosphorus removal, Sequence batch reactors.

Many municipalities and industrial plants with small quantities of wastewater are facing challenges with providing economical treatment strategies. They require simply designed and operated processes which give high quality effluent. One such process is the Intermittent Cycle Extended Aeration System (ICEAS R). This is a variant of the activated sludge biological process which allows continuous inflow of raw wastewater and intermittently discharged influent. It provides flow equalization, biological oxidation and sedimentation with decanting of supernatant in a single tank. The process can be operated on any cycle duration based on the required degree of treatment. Each cycle consists of aeration, sedimentation and decantation phases. The aeration phase can be operated on an oxic/anoxic mode for the purpose of nitrification/denitrification and biological phosphorus removal. To date, there are more than 100 plants worldwide and 25 within the USA that are built and operating successfully. High degrees of biochemical oxygen demand, suspended solids and nitrogen removal are obtained with the plants. Most of the small plants require minimal operating personnel, generally one or two, for continuous operation. (Author's abstract)
W90-07813

FULLY BIOLOGICAL WASTEWATER TREATMENT WITHOUT ENERGY CONSUMPTION.
L. Csepai.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 331-334, 1990. 6 fig.

Descriptors: *Biological wastewater treatment, *Energy costs, *Wastewater treatment, Ammonia, Austria, Biochemical oxygen demand, Chemical oxygen demand, Clarifying ponds, Costs, Nitrification, Nitrogen removal, Organic matter, Settling ponds, Trickling filters.

It was demonstrated in two Sewage Treatment Plants that fully biological wastewater treatment without external energy supply is possible provided there is a sufficient natural gradient to guarantee a free flow through the entire plant. Both plants have now been in operation for more than 2 years. Test results show a very good purification efficiency. Elimination of biochemical oxygen demand is over 93%, of chemical oxygen demand 84%, of TOC 86%, of NH4 66% and that of totals nitrogen 29%. The results of the two-year operation of both plants prove that smaller units allow for meeting all requirements to obtain a good purification efficiency. Pre-settling and final clarifying ponds with interposed trickling filters represent a very simple but economic addition to the ample variety of modern wastewater treatment techniques. When planning wastewater treatment plants, every effort should be made to adjust the hydraulic longitudinal sec-

tion to the existing area conditions, even at the risk of increased building costs. As far as economic considerations are concerned, a unit operating without energy consumption certainly proves advantageous. At the same time it offers a running guarantee, which is equally important, especially in the case of smaller units. If local communities experience prolonged economic difficulties such considerations gain increasing priority. In addition to all these advantages, the plants show a high buffering efficiency, minimum maintenance requirements and very low running costs. (Author's abstract)
W90-07814

SMALL DOMESTIC SEWAGE WORKS OF THE CARLSBAD-TYPE.
Vyzkumny Ustav Vodohospodarsky, Prague (Czechoslovakia).
K. Haindl.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 335-342, 1990. 11 fig,1 tab,6 ref.

Descriptors: *Biological wastewater treatment, *Wastewater treatment, Aeration, Biological oxygen demand, Chemical oxygen demand, Czechoslovakia, Ecology, Underground sewage works.

Small sewage works of the Carlsbad-type are biological wastewater treatment plants using activated sludge with aerobic stabilization. They are situated underground so their performance is constant in all seasons, independent of outside temperature. Oxidation of the biological suspension is based on the ring jump principle with creation of a spiral motion in the activated sludge tank. The ring jump, a hydraulic phenomenon on the transition of annular to full profile flow, entrains air and ensures a high oxygen transfer. The results of long term monitoring of the treatment effect show an average reduction of BOD5 of 97.8%, COD 93.0% and suspended solids 95.1% regardless of season. The sewage works are situated in close vicinity to houses, located under parks and gardens, and in mountain regions. They do not interfere with the landscape, are odor free and noiseless; their construction is done within a week, the only moving component is the pump. Their operation and attendance are simple, with low investment cost. (Author's abstract)
W90-07815

PACKED-ENTRAPPED-MIXED MICROBIAL CELLS FOR SMALL WASTEWATER TREATMENT.
Hawaii Univ. at Manoa, Honolulu. Dept. of Agricultural Engineering.
P. Y. Yang, and M. L. Wang.
Water Science and Technology WSTED4, Vol. 22, No. 3/4, p 343-350, 1990. 3 fig, 4 tab, 12 ref.

Descriptors: *Biological wastewater treatment, *Cellulose acetate, *Microbial degradation, *Wastewater treatment, Aeration, Comparison studies, Phenols.

The primary goal of the research is to develop and evaluate a biological treatment system in which mixed microbial populations are physically immobilized by entrapment. The immobilized system was evaluated initially for its ability to remove simple benzene-based compounds from a synthetic wastewater as a model for treating pesticide-containing waters. Cellulose triacetate was used as the preparation of monocarrier and combined cellulose triacetate and calcium alginate were used for the preparation of the bi-carrier. Phenol was used as substrate to test the entrapped mixed microbial cell process. Process performance including steady state, shock load and comparison of entrapped microbial cell process with and without entrapped microbial cell was investigated. It was concluded that the critical loading rate for phenol synthetic wastewater appeared to be 9 g chemical oxygen demand(COD)/L/day. The COD removal efficiency could be maintained higher than 90 %. Because of the low effluent suspended solid concentration, conventional-secondary-settling tanks could be eliminated. Also, the process could take both concentration and hydraulic shock loads of

phenol synthetic wastewater successfully without the need of external sludge recycling. The equalization and external sludge recycling facilities equipped in the conventional wastewater treatment plant could be eliminated. When the process is operated only at low COD loading rate (less than 1.3 g/L/day), entrapped cells might not be required. However, when operated at higher loading rate,combined absorbed and entrapped cells appeared to remove phenol more efficiently. For the application, mono-carrier (cellulose triacetate) is preferable to biocarrier (cellulose triacetate and calcium alginate), since it is easier to prepare and the operational performance is better. Therefore, the application of packed-entrapped mixed microbial cell process for treatment of small-toxic-organic wastewater holds great potential. (Author's abstract)
W90-07816

SHORT-DURATION RAINFALLS IN ITALY.
Palermo Univ. (Italy). Ist. di Idraulica.
For primary bibliographic entry see Field 2B.
W90-07834

INTERACTION OF METALS AND PROTONS WITH ALGAE: II. ION EXCHANGE IN ADSORPTION AND METAL DISPLACEMENT BY PROTONS.
Messiah Coll., Grantham, PA.
R. H. Crist, J. R. Martin, P. W. Guptill, J. M. Eslinger, and D. R. Crist.
Environmental Science and Technology ESTHAG, Vol. 24, No. 3, p 337-342, March 1990. 7 fig, 2 tab, 23 ref.

Descriptors: *Adsorption, *Algae, *Bioindicators, *Ion exchange, *Path of pollutants, *Wastewater treatment, Calcium, Cations, Chemical interactions, Copper, Heavy metals, Hydrogen ion concentration, Magnesium, Metals, Separation techniques, Strontium.

Adsorption of Sr on Vaucheria algae released an equivalent amount of Ca and Mg, indicating that metal adsorption by alkali and alkaline-earth metals is an ion-exchange phenomenon based on electrostatic interactions. Release of protons when Cu was adsorbed demonstrated additional covalent bonding for this transition metal. Protonated ethylenediamine is adsorbed both as a cation similar to metals and as a neutral species, indicating the presence of additional bonding sites. When the pH of an algal suspension is decreased, Ca and Mg are released equivalent to the amount of proton uptake, which occurred in fast (< 50 sec) and slow (2 hr) processes. Kinetic evidence suggests that the slow process represents rate-determining diffusion of Ca through a dense-phase structure of the alga. (Author's abstract)
W90-07884

EFFECTS OF THE ACTIVITY OF HETEROTROPHS ON NITRIFICATION IN A SUSPENDED-GROWTH REACTOR.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
K. Hanaki, C. Wantawin, and S. Ohgaki.
Water Research WATRAG, Vol. 24, No. 3, p 289-296, March 1990. 10 fig, 5 tab, 9 ref.

Descriptors: *Ammonia, *Nitrification, *Wastewater reactors, *Wastewater treatment, Biomass index, Glucose, Growth rates, Heterotrophs, Kinetic constants, Organic matter, Oxidizers, Toxic effects.

Ammonia (80 mg/L as N), with various concentrations of glucose, was continuously fed to laboratory scale reactors at 25 C to examine the effect of the activity of heterotrophs on nitrification. The assimilation of ammonia by heterotrophs happened in preference to nitrification, and reduced the available ammonia for nitrification. Glucose addition of 160, 500 or 1000 mg/L (as chemical oxygen demand) decreased ammonia removal and ammonia oxidation to nitrite, and elevated the effluent ammonia concentration. The results clearly indicate that the addition of organic matter, which

provokes the growth of heterotrophs, inhibits ammonia oxidation. Determination of the biomass index with batch experiments enabled estimation of kinetic constants for ammonia oxidizers (maximum specific growth rate = 0.66/day, saturation constant = 1.0 mg/L) and for nitrite oxidizers (maximum specific growth rate = 0.58/day, saturation constant = 0.35 mg/L) when no glucose was added. The addition of glucose to the reactor resulted in a high saturation constant (7.2 mg/L when 1000 mg/L of chemical oxygen demand was added) whereas maximum specific growth rate was unchanged in the ammonia oxidation. It is suggested that inhibition takes place by decreasing the affinity between the ammonia oxidizers and ammonia. Experiments using acetate showed that toxic effects by organic matter is unlikely. One hypothesis is that transportation of ammonia from bulk water to the cell of the ammonia oxidizer is hindered by the presence of the crowded cells of the heterotrophs. Nitrite oxidation was not directly affected by organic loading. (Author's abstract)
W90-07909

NITRIFICATION AT LOW LEVELS OF DISSOLVED OXYGEN WITH AND WITHOUT ORGANIC LOADING IN A SUSPENDED-GROWTH REACTOR.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
K. Hanaki, C. Wantawin, and S. Ohgaki.
Water Research WATRAG, Vol. 24, No. 3, p 297-302, March 1990. 6 fig, 2 tab, 12 ref.

Descriptors: *Nitrification, *Nitrogen removal, *Wastewater treatment, Ammonia oxidation, Denitrification, Dissolved oxygen, Glucose, Mixed flow reactors, Organic loading.

Laboratory-scale mixed flow reactors with DO (dissolved oxygen) control were operated at 25 C using substrate containing 80 mg/L of ammonia nitrogen. DO of 0.5 mg/L produced no effect on ammonia oxidation of the reactor. Determination of the biomass index based on the substrate utilization rate revealed that low levels of DO elevated the growth yield of ammonia oxidizers by double. This high growth yield compensated the reduced specific substrate utilization rate at low levels of DO. Kinetic analysis showed that the maximum specific growth rate value was not significantly changed by low DO because of the elevated growth yield. Growth yield of nitrite oxidizers was not increased by low DO. Nitrite oxidation was strongly inhibited by 0.5 mg/L of DO, and accumulated nitrite reached almost 60 mg/L. The saturation constant in terms of DO, estimated based on specific substrate utilization rate, was 0.32 mg/L for ammonia oxidation, while this value for nitrite oxidation could not be obtained. The interacting effect of low DO and organic loading was examined by adding glucose to the substrate. The inhibitory effect on ammonia oxidation by organic loading through heterotrophic activity was enhanced by low DO. The results suggest that the value for the saturation constant for DO in a system with organic loading is larger than the above value which was estimated in a system without organic loading. Simultaneous nitrification and denitrification took place to some extent when glucose was fed at low DO. (Author's abstract)
W90-07910

SULPHIDE REMOVAL FROM ANAEROBIC WASTE TREATMENT EFFLUENT OF A PAPERMILL.
Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
C. J. N. Buisman, and G. Lettinga.
Water Research WATRAG, Vol. 24, No. 3, p 313-319, March 1990. 7 fig, 3 tab, 9 ref.

Descriptors: *Anaerobic digestion, *Industrial wastes, *Pulp and paper industry, *Sulfide removal, *Sulfides, *Wastewater treatment, Biorotor reactors, Clogging, Hydraulic retention time, Polyurethane sheets, Rasschig rings, Rotation speed, Upflow reactors.

A laboratory-scale (20 L) upflow reactor and a laboratory-scale (6 L) biorotor reactor, which had

been previously tested using composite wastewaters, were investigated for their suitability for sulfide removal from anaerobically treated papermill wastewater. Upon treating this wastewater, clogging problems occurred in the upflow reactor with all types of carrier material, and in the biorotor only with polyurethane sheets. These problems did not occur with synthetic wastewater without organic compounds using the same reactor. Due to these problems it was concluded that the upflow reactor, at least in the configuration investigated, was not suitable for this type of wastewater. In the biorotor reactor sulfur reduction and clogging could be prevented by using Rasschig rings as carrier material at a rotation speed of 46 rpm. In this configuration of the biorotor reactor a sulfide removal rate of 620 mg/L/hr was found at a hydraulic retention time of 13 min with a removal efficiency of 95%. At lower rotation speeds the removal efficiency deteriorated seriously. Using polyurethane sheets or particles instead of the Rasschig rings the removal efficiency also decreased in the biorotor reactor. (Author's abstract)
W90-07912

SORPTION EQUILIBRIA FOR TRICHLOROETHENE ON ALGAE.
Advanced Environmental Control Technology Research Center, Urbana, IL.
B. F. Smets, and B. E. Rittmann.
Water Research WATRAG, Vol. 24, No. 3, p 355-360, March 1990. 1 fig, 2 tab, 43 ref.

Descriptors: *Algae, *Bioaccumulation, *Biological treatment, *Trichloroethene, *Wastewater treatment, Biotransformation, Solvents, Sorption, Stabilization lagoons.

The sorption of chlorinated solvents by algae can remove the solvents from natural waters and wastewaters treated in stabilization lagoons and other phototrophically active treatment processes. The equilibrium sorption of 14C-labeled trichloroethene (TCE) to three species of algae--Chlorella vulgaris, Scenedesmus quadricauda and Selenastrum capricornutum--was studied in batch reactors in which no biotransformations occurred. The sorption density was nonlinear with respect to equilibrium TCE concentration. The Freundlich isotherm successfully described the sorption equilibria. Thus, the apparent bioconcentration factor (BCF) increased with increasing TCE concentrations. Empirical correlations that predict the BCF as a function of the compound's octanol-water partition coefficient gave BCF values about one order of magnitude lower than shown by these experiments with algae. The content and distribution of lipids within the algae appear to cause substantially greater sorption by algae than by other forms of organic solids. (Author's abstract)
W90-07919

FLOCCULATION IN A FLUIDIZED BED (FLOCULATION EN LIT FLUIDISE).
Montpellier-2 Univ. (France). Inst. des Sciences de l'Ingenieur.
J. Coma, A. Jabbouri, A. Grasmick, and S. Elmaleh.
Water Research WATRAG, Vol. 24, No. 3, p 361-366, March 1990. 7 fig, 5 tab, 7 ref. English summary.

Descriptors: *Flocculation, *Fluidized bed process, *Primary wastewater treatment, *Wastewater treatment, Chemical destabilization, Efficiency, Energy, Settling velocity, Turbidity.

The turbidity abatement in a fluidized bed followed by a multitubular settler and the turbidity abatement attained by two homogeneous flocculators, i.e. a jar-test and a floc-test, operated in identical energetic conditions are compared. The energy dissipation is quantified using the classical velocity gradient, G, and the Camp number (Ca). Velocity gradient and Camp number are calculated with the torque in the jar-test, with the pressure drop in the floc-test and with the equation proposed by Coma in the fluidized bed. These relationships show that the parameters G and Ca can be predicted for given operational conditions. The units were operated using the urban wastewater of

Montpellier first without addition of any destabilizing agent, i.e. autoflocculation, and then with the addition of ferric chloride. A sand fluidized bed allows 60% abatement of turbidity and is therefore close to the performance of the homogeneous flocculators with less favorable energetic conditions, the 210/sec velocity gradient being eight times greater. A resin-particles fluidized bed, which provides better energetic conditions (G = 70/sec), allows 70% abatement to be reached. The best chemical destabilizing performances are obtained with the resin-particles fluidized bed, where 95% efficiency is reached with a requirement of 80 mg/L of ferric chloride instead of 150 mg/L needed in the homogeneous flocculators. The fluidized flocculator allows, therefore, a dramatic reduction of the residual sludge (leading, to significant savings in the operational costs). Plots of efficiency vs G and Ca are similar to the autoflocculation plots. The autoflocculated sludge can compare with a primary sludge but its better settling velocity could intensify the sludge treatment. Thus, the autoflocculation of urban wastewater in a fluidized bed shows better pollution abatement, i.e. 60-70% of inlet turbidity with a total mean residence time of less than 15 min. The efficiency reaches 90% with prior chemical destabilization, the flocculent concentration being, however, reduced by half of the requirement in classical devices. (Author's abstract)
W90-07920

GAS-SOLID-LIQUID SEPARATOR IN ANAEROBIC TREATMENT OF WASTEWATER.
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
S. J. Hashemian, and A. James.
Water Research WATRAG, Vol. 24, No. 3, p 381-382, March 1990. 4 tab, 6 ref.

Descriptors: *Anaerobic digestion, *Gas/solid/liquid separation, *Wastewater treatment, Charcoal filters, Sludge bed reactors.

Gas-solid-liquid separation is one of the most important parts of the upflow anaerobic sludge blanket treatment plant. Two sludge bed reactors were constructed from PVC tubes 100 cm long with an internal diameter of 155 mm, and a volume of approximately 17 L. The separator occupied 16-25% of the reactor volume and any blockage in gas separator compartment can cause failure in solid separation. A layer of floating charcoal is an appropriate and inexpensive alternative separator and has been successfully tested in this study. (Author's abstract)
W90-07923

OPTIMIZATION OF NUMBER OF CELLS FOR MINIMUM LAND REQUIREMENT IN A SERIES REACTOR.
University Coll., Cardiff (Wales). Dept. of Physics.
S. K. Sharma.
Water Research WATRAG, Vol. 24, No. 3, p 395-397, March 1990. 3 fig, 6 ref.

Descriptors: *Stabilization ponds, *Wastewater reactors, *Wastewater treatment, Land requirements, Series reactors, Surface area requirements.

Optimization of the number of cells in a series reactor was considered from the point of view of minimization of land requirement in waste stabilization pond systems. A formula is presented which gives the surface area requirement of a series reactor in terms of the surface area requirement of a single pond system, for the same pond performance. Numerical estimates have been presented. A large and most significant gain in terms of area requirement occurs in going from 1 cell to 2 cell series. Analysis of examples considered indicates that while for a small maturation unit a value for number of cells (n) = 3 or 4 may be optimal, the desired value of n for larger systems may be n = 4 or 5. (Author's abstract)
W90-07926

Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D—Waste Treatment Processes

REVIEW OF TREATMENT PROCESS OPTIONS TO MEET THE EC SLUDGE DIRECTIVE.
Water Research Centre, Swindon (England). Swindon Engineering Centre.
A. M. Bruce, E. B. Pike, and W. J. Fisher.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 1-13, February 1990. 5 fig, 3 tab, 21 ref, append.

Descriptors: *Pathogens, *Public health, *Sludge treatment, *Sludge utilization, *Wastewater treatment, Agriculture, Economic aspects, Economic evaluation, European Commission Directive, Fermentation, Salmonellosis, Tapeworm, United Kingdom National Code of Practice.

New United Kingdom (UK) regulations from June 1989 will enforce the provisions of a European Commission (EC) Directive on the use of sewage sludge in agriculture. Among the requirements is one that sludge should be treated before surface application to farmland. Treatment is needed to reduce 'significantly' both the fermentability of sludge and the health hazards resulting from its use on farms. In the UK, the health risks associated with sludge are principally beef tapeworm (Taenia saginata and cysticercosis) and salmonellosis. Research on the effects of various treatment processes on pathogens has shown the conditions required to produce a 90% reduction of Taenia saginata and Salmonellae. This information has been used as a basis for describing a list of 'effective' treatment processes and process conditions, as given in a new UK National Code of Practice on the use of sludge in agriculture. The uprating of existing treatment plant, or provision of new plant, to meet the Code of Practice recommendations could involve significant costs. A comparison of the economics of each of the 'effective' treatment processes for different population sizes shows a fairly wide range of net present costs. In general, increased sludge quality means increased costs. (Author's abstract)
W90-07927

ON-SITE TREATMENT OF LEACHATES FROM LANDFILLED WASTES.
Aspinwall and Co., Shrewsbury (England).
H. D. Robinson.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 78-89, February 1990. 11 fig, 3 tab, 10 ref.

Descriptors: *Landfills, *Leachates, *Wastewater lagoons, *Wastewater treatment, Aerobic digestion, Ammonia, Fate of pollutants, Nitrification, Reeds.

The large accumulation of putrescible materials which comprise a modern landfill have potential to generate quantities of highly-polluting leachate as they decompose anaerobically over many years. Operators must control and manage such leachates if severe environmental impacts are to be avoided. Progress has been made in the development of simple, automatic, robust and reliable systems as full-scale plants have been installed at English landfills during the last decade, with the assistance of the Department of the Environment funding to allow detailed monitoring of particular schemes. A leachate control facility was installed at one site, Sands Farm, to overcome a particularly difficult leachate problem, where high ammonia concentrations had posed a threat to local watercourses. Since January 1986, all leachate has been treated as it has arisen. An experimental-scale gravel reed-bed system has just been constructed at the site to treat 33% more of the plant's effluent load. The intention is to produce a final effluent which could be discharged directly into a surface watercourse. (Brunone-PTT)
W90-07936

FILTER FABRIC CONTROLS QUICKSAND DURING SEWER CONSTRUCTION.
H. A. Lauterwald.
Public Works PUWOAH, Vol. 121, No. 3, p 43, March 1990. 1 fig.

Descriptors: *Construction methods, *Fabrics, *Pipelines, *Quicksand, *Sewers, Backfill, Civil engineering, Economic factors, Filter fabric, Groundwater, New Jersey, Shore boxes, Soil stabilization.

The municipal engineer is often required to construct small sewer projects under various conditions. Quicksand encountered during pipe laying can easily double or triple costs and create serious budget problems. On two recent sewer replacement projects in North Plainfield, New Jersey, rafting of quicksand was economically accomplished using non-woven filter fabric and careful construction procedures. Tight sheeting and well points are the best method of handling quicksand, but their high costs for small projects are difficult to justify. Pipe laying requires that stabilization is necessary only long enough to install pipe and backfill. When groundwater has returned to its original level, the foundation is secure. In the North Plainfield projects, non-woven filter fabric installed over quicksand and held down with clean stone provided the stability necessary for pipe laying, left sufficient voids to de-water by ordinary pumping, and allowed use of stone in an economical depth. Shore boxes were set above the pipes to allow access to house service connections. Skillful maneuvering of the shore box and road plates, combined with rapid pipe placement and back-filling, produced excellent results. (Brunone-PTT)
W90-07945

RENOVATING THE PUBLIC LABORATORY.
Laboratory Consultants, Albuquerque, NM.
For primary bibliographic entry see Field 5F.
W90-07946

MANURE MANAGEMENT AND POLLUTION PREVENTION.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
T. M. Younos.
Water Environment & Technology, Vol. 2, No. 3, p 54-57, March 1990. 4 fig.

Descriptors: *Animal wastes, *Manure, *Waste management, *Waste treatment, *Water pollution control, Aerobic stabilization, Anaerobic lagoons, Animal confinement systems, Animal production, Aquaculture, Dehydration, Ensilage, Integrated manure management, Oxidation ditches, Waste recovery.

In this century, crop and animal production units have been separated, with a shift from pasture production to intensive animal confinement systems and regional centralization of livestock production systems. This shift has resulted in enormous increases in highly concentrated manure loads and increased demand for the design and construction of more effective animal waste treatment systems. Many livestock operation systems adopted anaerobic lagoons to treat animal waste. Several aerobic processes have also been applied to animal waste treatment. Oxidation ditches are the most widely used system in confined animal production facilities. The concept of waste management has also been extended to manure processing for refeeding to livestock. Manure processing methods include dehydration, aerobic stabilization, ensilage, and chemical treatment. Culturing of fish and aquatic plants for waste treatment recently has received renewed attention. By using animal manure as a nutrient source for aquaculture systems, resource recovery as well as waste treatment can be achieved. In the coming decades, research should focus on developing an integrated manure management system, incorporating several waste management techniques within an integrated crop-animal system. (Brunone-PTT)
W90-07953

PLANT FOR ALL SEASONS.
Willow Lake Wastewater Treatment Plant, Salem, OR.
F. Collins, P. Eckley, and J. Detweiler.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 4, p 48-49, 1989.

Descriptors: *Biochemical oxygen demand, *Energy costs, *Food-processing wastes, *Oregon, *Wastewater treatment, Activated sludge, Domestic wastewater, Industrial wastewater, Trickling filters.

Since modifying its treatment system to adjust to sharply different seasonal needs, Salem, Oregon's Willow Lake Wastewater Treatment Plant is reaping substantial energy savings and producing its best-quality effluent ever. For most of the year, Willow Lake provides secondary sewage treatment for a mostly residential population of 130,000. During the summer-autumn fruit and vegetable-canning season, the Willow Lake plant has a biochemical oxygen demand (BOD) ranging from 300 to 500 milligrams/L. In 1974, the plant was upgraded with a UNOX process to operate in parallel with existing trickling filters. This process improved overall plant performance, provided capacity to handle the high canning-season loads and increased the plant's hydraulic capacity. To improve energy efficiency the trickling filters with the UNOX basins were equipped with a fine-bubble diffused aeration system. This allowed the plant to operate as a trickling-filter activated sludge process (TF/AS). The energy-intensive UNOX process is operated only when needed during the high-load canning season. In the low-load non-canning season, the plant operates in the TF/AS mode. The TF/AS process provided the highest quality effluent the plant has ever had, with BOD and suspended solids consistently as low as 10 and 11 milligrams/L, respectively. No major problems were encountered when switching between UNOX and TF/AS. The TF/AS process will serve as the basis for Willow Lake's future expansion with construction of additional high-rate trickling filters to provide capacity for TF/AS operation during all seasons. (Geiger-PTT)
W90-07959

RECIPROCAL RECYCLING.
Camp, Dresser and McKee, Inc., Clearwater, FL.
For primary bibliographic entry see Field 3C.
W90-07961

DYNAMICALLY FORMED HYDROUS ZIRCONIUM (IV) OXIDE-POLYELECTROLYTE MEMBRANES: V. NON-HOMOGENEOUS POLY(ACRYLIC ACID-COVINYL ALCOHOL) MEMBRANES: REJECTION AND FLUX PROPERTIES AND THE TREATMENT OF COAL GASIFICATION WASTE WATER.
Stellenbosch Univ. (South Africa). Inst. for Polymer Science.
A. J. Van Reenen, and R. D. Sanderson.
Desalination DSLNAH, Vol. 72, No. 3, p 319-328, January 1989. 5 fig, 1 tab, 16 ref.

Descriptors: *Coal wastes, *Filtration, *Membrane processes, *Polyelectrolytes, *Polymers, *Wastewater treatment, Coal gasification, Industrial wastewater, Membrane filters, Organic acids, Phenols, Separation techniques.

A non-homogeneous poly(acrylic acid-covinyl alcohol) copolymer (I) was synthesized. This copolymer was used as the polyelectrolyte in a dynamically formed hydrous zirconium (IV) oxide-polyelectrolyte membrane. The resultant Zr(I) membrane gave salt rejection figures exceeding 99% and flux values of 2500 lmd. A set of these Zr(I) membranes was used to treat a coal gasification wastewater in a laboratory experiment, and the membranes rejected a wide variety of constituents except the divalent cations present. The rejections of phenols and organic acids were good, as was the rejection of the hydantoins. No sign of membrane degradation occurred over a 336 hr period. (Author's abstract)
W90-07968

MODELLING MICROALGAL PRODUCTIVITY IN A HIGH RATE ALGAL POND BASED ON WAVELENGTH DEPENDENT OPTICAL PROPERTIES.
Amsterdam Univ. (Netherlands). Lab. voor Microbiologie.
B. M. A. Kroon, H. A. M. Ketelaars, H. J. Fallowfield, and L. R. Mur.

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Journal of Applied Phycology JAPPEL, Vol. 1, No. 3, p 247-256, 1989. 8 fig, 21 tab, 24 ref.

Descriptors: *Algae, *Animal wastes, *Biological wastewater treatment, *Mathematical models, *Productivity, *Waste treatment, *Wastewater treatment, Aerobic treatment, Biomass, Optical properties, Photosynthesis, Pond management, Retention time, Simulation analysis, The Netherlands, Water depth, Water pollution prevention, Wavelengths.

The disposal of agricultural waste from pig production is a significant problem in The Netherlands because of the limited area of land available for disposal. Aerobic treatment, while lowering the organic content, still results in an effluent rich in nitrogen and phosphorus. Controlled growth of algae in a High Rate Algal Pond (HRAP)--an outdoor well-mixed open continuous culture system--may be one method by which further removal of N and P can be achieved through incorporation into algal biomass, reducing the potential for environmental effects like eutrophication of open water. A model is presented to predict algal biomass concentration and productivity in an HRAP at all possible combinations of incident photon flux density (PFD), pond depth and hydraulic retention time (HRT). The total extinction coefficient kt and the absorption coefficient ka of algal biomass were measured at 1 nm intervals. The kt values were used to calculate the underwater light climate, which included the spectral narrowing of the photon flux density with increasing depth. The number of quanta absorbed (QA) from the photosynthetic available radiation (PAR) was calculated using the ka/kt ratio and incident PFD at 1 mn intervals. Algal oxygen production is related to QA by the quantum requirement (QR), which was determined from ka and the slope of the photosynthesis vs. irradiance curve. Based on this calculation a new concept is proposed: the compensating absorption rate, which represents the rate of photon absorption necessary to balance oxygen consumption processes. The model calculated productivities using literature data on HRT, pond depth and incident PFD that compared well with the actual measured productivities. To achieve optimal HRAP productivities under fluctuating climatological conditions, a pond management strategy based on model simulations is proposed. (Sand-PTT)
W90-08001

REACTION OF ORGANIC NITROGEN COMPOUNDS WITH CHLORINE AND CHLORINE DIOXIDE.
Howard Univ., Washington, DC. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-08008

BIODEGRADATION OF AZO DYES IN MULTISTAGE ROTATING BIOLOGICAL CONTACTOR IMMOBILIZED BY ASSIMILATING BACTERIA.
Gifu Univ. (Japan). Dept. of Chemistry.
T. Ogawa, and C. Yatome.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 44, No. 4, p 561-566, April 1990. 4 fig, 2 tab, 15 ref.

Descriptors: *Azo dyes, *Bacteria, *Biological wastewater treatment, *Dye industry wastes, *Dyes, *Wastewater treatment, Activated sludge process, Adsorption, Benzenes, Biodegradation, Coagulation process, Dissolved air flotation process.

Wastewaters from dyeing and finishing processes contain a large amount of organic substances such as thickening agents, as well as dyes. The activated sludge process has been frequently applied to the removal of organic substances. Most plants utilize a combined process of the activated sludge process for various organic substances and a coagulation or dissolved air flotation process for the dye. The azo dye assimilating bacteria (Pseudomonas cepacia) may be able to remove both the organic substances and the dye in a single process. Model wastewater was treated by a rotating biological contactor with

a disk on which Pseudomonas cepacia 13NA was immobilized with kappa-carrageenan gel. The rate of elimination of p-aminoazobenzene was almost constant after approximately 100 hours because the elimination ability was kept stable. The retention time in the wastewater treatment was kept short so that larger amounts of water could be treated. The elimination of the p-aminoazobenzene was attributed to either the adsorption on the gel or the biodegradation. Poorer nutrient concentration and quality of the wastewater produced higher degradation rate constants. It may be possible to keep both the growth of the microbe and the degradation of the dye high by periodically changing the solution path in the wastewater treatment plant. (Brunone-PTT)
W90-08023

NOVEL 2500 GPD 5-EFFECTS WIPED-FILM ROTATING-DISK VAPOR-COMPRESSION MODULE: PRELIMINARY RESULTS.
Tleimat and Associates, Alamo, CA.
For primary bibliographic entry see Field 3C.
W90-08055

INDUSTRIAL WATER POLLUTION CONTROL.
Vanderbilt Univ., Nashville, TN. Dept. of Environmental and Water Resources Engineering.
W. W. Eckenfelder.
McGraw-Hill Book Co., New York. 1989. 400p.

Descriptors: *Biological wastewater treatment, *Industrial wastewater, *Wastewater treatment, *Water pollution control, Adsorption, Case studies, Ion exchange, Primary wastewater treatment, Regulations, Secondary wastewater treatment, Sludge digestion, Sludge disposal, Tertiary wastewater treatment, Waste recovery, Water reuse.

This book covers industrial wastewater treatment from an initial characterization of its sources and properties through the sludge handling and disposal. Pre- and primary treatment methods discussed are equalization, neutralization, sedimentation, oil separation, and flotation. Coagulation and precipitation including heavy metals removal are considered. Aeration mechanisms and equipment are described as is air stripping of volatile organics. Other topics discussed include biological oxidation, biological wastewater treatment processes (lagoons, aerated lagoons, activated sludge, trickling filtration, rotating biological contactors, and anaerobic decomposition); adsorption, properties of activated carbon, and the PACT (powdered activated carbon) process; ion exchange; and chemical oxidation. Miscellaneous treatment processes covered are land treatment, deep-well disposal, membrane processes, phosphorus removal,and filtration. (Author's abstract)
W90-08137

BIOTREATMENT OF AGRICULTURAL WASTEWATER.
CRC Press, Inc., Boca Raton, Florida. 1989. 176p. Edited by Mark E. Huntley.

Descriptors: *Agricultural runoff, *Agricultural wastes, *Biological wastewater treatment, *Symposium, *Wastewater treatment, Agricultural chemicals, Algae, Bacteria, Biological treatment, Biotechnology, Economic aspects.

This book is based on a symposium held in Lake Arrowhead, California in 1986, supported by a coalition of federal, state, and local agencies. It is a synopsis of topics covered by world renowned experts on the biology and aquaculture of algae and bacteria and on the engineering of industrial scale systems for biological wastewater treatment. Economists also gathered at the symposium to evaluate historically proven systems. Chapter titles are: subsurface agricultural drainage in California's San Joaquin Valley; deciding on a treatment alternative; current options in treatment of agricultural drainage wastewater; biotechnology in environmental engineering; modern biological methods--the role of biotechnology; bacterial decontamination of agricultural wastewaters; algae as ideal

waste removers--biochemical pathways; algal culture systems; the role of microalgae in removal of selenate from subsurface tile drainage; the engineering of microalgae mass cultures for treatment of agricultural wastewater, with special emphasis on selenium removal from drainage waters; is there an 'Uncertainty Principle' in microbial waste treatment; and biological treatment--an entrepreneurial opportunity. (See W90-08142 thru W90-08152) (Lantz-PTT)
W90-08141

DECIDING ON A TREATMENT ALTERNATIVE.
Woodward-Clyde Consultants, San Diego, CA.
For primary bibliographic entry see Field 6B.
W90-08143

CURRENT OPTIONS IN TREATMENT OF AGRICULTURAL DRAINAGE WASTEWATER.
San Joaquin Valley Drainage Program, Sacramento, CA.
E. W. Lee.
IN: Biotreatment of Agricultural Wastewater. CRC Press, Inc., Boca Raton, Florida. 1989. p 33-45, 3 fig, 4 tab, 33 ref.

Descriptors: *Agricultural runoff, *Decision making, *San Joaquin Valley, *Wastewater treatment, Adsorption, Biological treatment, Chemical precipitation, Chemical treatment, Desalination, Electrochemistry, Selenium.

The treatment of agricultural drainage is a technology research and development issue. In the San Joaquin Valley of California, emphasis was shifted in the 1960s from traditional concerns with salinity to include the broader issues of eutrophication and contamination by pesticides. Recent discoveries of dead and deformed birds at Kesterson Reservoir, a receiving basin for agricultural drainage in the central San Joaquin Valley, have focused attention on toxic trace elements, particularly selenium. A comprehensive plan is currently under development for the management of agricultural drainage in the San Joaquin Valley. The San Joaquin Valley Drainage Program (SJVDP), a state and federal interagency program, is developing the management plan. Current studies in the San Joaquin Valley are focused on salinity and selenium, since these two substances present the most difficult technological challenge. Boron and other trace elements have been identified by the State Water Resources Control Board for regulatory action, and other trace elements have been identified as cause for concern. At this stage of the program, an effective technology has not been developed to determine the feasibility for salt and selenium reduction, although several promising processes are under evaluation. The technologies selected for the treatment of agricultural drainage water for salt and selenium removal can be broadly categorized into five basic systems: desalination, biological, chemical precipitation, adsorption, and electrochemical. Each of these is briefly described and evaluated, on both an economic and performance basis, in this chapter. There are other options with some degree of promise that have been under review, but which have not been followed up with detailed studies to date. These include the use of aquatic plants, aquaculture (fishery and shellfish), and silviculture systems, all of which are primarily for the disposal and reuse of drainage waters, although treatment by biological uptake and removal is inherent in these processes. (See also W90-08141) (Lantz-PTT)
W90-08144

BIOTECHNOLOGY IN ENVIRONMENTAL ENGINEERING.
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
G. Shelef.
IN: Biotreatment of Agricultural Wastewater. CRC Press, Inc., Boca Raton, Florida. 1989. p 47-51.

Descriptors: *Biological treatment, *Biotechnology, *Wastewater treatment, Aerobic treatment,

Group 5D—Waste Treatment Processes

Anaerobic digestion, Biological wastewater treatment, Biomass, Denitrification, Fermentation.

One of the principal tasks of the environmental engineering profession (formerly sanitary engineering) is the treatment of liquid, semiliquid, and solid organic wastes of municipal, agricultural, and industrial origin. Biological treatment using bioengineering processes (hence, biotechnological methods) has been established as the most efficient and economical way to remove organic compounds once a biological metabolic pathway exists. Since the early 1970s there has been an upsurge of sophisticated and efficient biological processes, backed by process kinetics, contemporary biotechnological reactor design, and better process control. In the treatment of wastes, environmental engineering biotechnology (EEB) has used almost every type of process bioengineered in a microorganism that 'classical' fermentation biotechnology (CFB) ever used. These processes include: (1) aerobic fermentation; (2) anaerobic fermentation; (3) anoxic processes; (4) alcohol fermentation of municipal and agricultural solid wastes; and (5) microalgal biomass processes. The differences between EEB and CFB are discussed with respect to substrate (biochemical oxygen demand, chemical oxygen demand, and total organic carbon); substrate concentration and process kinetics; biomass; and size, flow and process control. Since the introduction of biological wastewater treatment, EEB has been questing for a 'superbug' which will either markedly increase process efficiency or degrade and remove difficult-to-treat compounds. Selection, adaptation, acclimatization, and even induced mutation have been tried, and vendors have sold concentrated bacterial cultures of 'superbugs' promising astonishing results. On at least two occasions, the fate of such labeled 'superbugs' was followed in field-scale biological reactors, only to find that they disappeared within a week. Genetic engineering, with its new advances in recombinant DNA, gene cloning, and DNA probing, can be most instrumental in the 'creation' of the long-sought 'superbug'. Assuming such a gene-altered bacterium will be introduced and tested in the laboratory, classical biotechnology will still have to determine the optimal ecological conditions necessary for this organism to grow, and they will have to find proper reactor design and reactor operating conditions which favor the new organism's capabilities. (See also W90-08141) (Lantz-PTT)
W90-08145

MODERN BIOLOGICAL METHODS: THE ROLE OF BIOTECHNOLOGY.
Tennessee Univ., Knoxville. Center for Environmental Biotechnology.
G. S. Sayler, and J. W. Blackburn.
IN: Biotreatment of Agricultural Wastewater. CRC Press, Inc., Boca Raton, Florida. 1989. p 53-71, 5 fig, 4 tab, 39 ref.

Descriptors: *Biological wastewater treatment, *Biotechnology, *Genetic engineering, *Wastewater treatment, Bacteria, Biodegradation, DNA, Microbial degradation, Microbiological studies, Technology.

Over the past two decades, developments in recombinant DNA technology have promoted a virtual explosion of research and new knowledge in modern molecular biology. The direct use of microorganisms and their capabilities to solve environmental problems and for in situ agricultural and industrial applications can be defined operationally as environmental biotechnology. Applications include detoxification and/or destruction of pollutants and hazardous wastes, improvements in soil fertility and crop productivity, biological pest management, and restoration and renovation of perturbed ecosystems. The applications for molecular biology and recombinant DNA technology in the management of hazardous agricultural wastes and environmental decontamination fall into three general areas: (1) isolation and microbial strain improvement for developing microorganisms with greater capacity for destruction of hazardous wastes and environmental contaminants; (2) field-site evaluation of microbial degradation processes contributing to overall contaminant fate predic-

tions in a given system; and (3) development, monitoring, and control of engineered processes for the biological destruction of hazardous waste and environmental contaminants. Each of these areas benefit directly from knowledge and research tools made available by molecular biology. However, it is the area of strain development or improvement which has received most of the popular, if not technical, attention. This attention has been directed toward research to develop genetically engineered microorganisms with new or improved biodegradative capabilities. While this is an important area of research with potentially significant contributions to developing biological treatment processes for difficult-to-degrade contaminants, molecular biology knowledge and recombinant DNA technology can also contribute to the development of nonengineered biodegradative microorganisms and processes. It can also be demonstrated that this same knowledge and technology will contribute, with even greater impact, to the successful understanding and utilization of microorganisms for hazardous waste control. (See also W90-08141) (Lantz-PTT)
W90-08146

BACTERIAL DECONTAMINATION OF AGRICULTURAL WASTEWATERS.
Idaho Univ., Moscow. Dept. of Bacteriology and Biochemistry.
R. L. Crawford, and K. T. O'Reilly.
IN: Biotreatment of Agricultural Wastewater. CRC Press, Inc., Boca Raton, Florida. 1989. p 73-89, 9 fig, 95 ref. PHS Grant ESO3270-02.

Descriptors: *Bacteria, *Biodegradation, *Farm wastes, *Fate of pollutants, *Reviews, *Wastewater treatment, Biological treatment, Chlorinated hydrocarbons, Halogenated pesticides, Herbicides, Microbial degradation, Organic pollutants, Phenols, Polynuclear aromatic hydrocarbons, Pseudomonas.

The EPA lists more than 60,000 chemicals marketed in the U.S., with more than 1,000 new compounds added to the list yearly. Many of these chemicals are produced for use in agriculture, with water and/or soil often the primary final repositories for these toxic compounds. Microorganisms have amazing abilities when it comes to degradation of organic molecules. Virtually all naturally produced organic compounds, including natural products bearing unusual substituents such as halogen atoms, are degradable by some microbe or consortium of microbes. Some pure cultures of bacteria of the genus Pseudomonas can use more than 100 natural compounds as sole sources of carbon and energy. Fortunately, this catabolic versatility extends to many anthropogenic compounds as well. Microbes are not infallible, but they come close. This review article summarizes some of the most recent physiological and biochemical work being performed on the biodegradation of toxic, anthropogenic chemicals, including: chlorinated phenols, haloalkanes, nitroaromatic molecules, chlorinated biphenyls, chlorinated phenoxy herbicides, chlorobenzenes, and, aromatic and polynuclear aromatic hydrocarbons. (See also W90-08141) (Lantz-PTT)
W90-08147

ALGAE AS IDEAL WASTE REMOVERS: BIOCHEMICAL PATHWAYS.
University of Southern Mississippi, Bay St. Louis. Center for Marine Science.
D. G. Redalje, E. O. Duerr, J. de la Noue, P. Mayzaud, and A. M. Nonomura.
IN: Biotreatment of Agricultural Wastewater. CRC Press, Inc., Boca Raton, Florida. 1989. p 91-110, 2 fig, 3 tab, 171 ref.

Descriptors: *Algae, *Biological wastewater treatment, *Fate of pollutants, *Genetic engineering, *Wastewater treatment, Agricultural runoff, Biological treatment, Farm wastes, Herbicides, Metals, Nitrogen, Nutrients, Organic pollutants, Pesticides, Phosphorus.

Microalgae have often been considered ideal waste removers for sewage effluents because of their requirements for dissolved forms of both nitrogen

and phosphorus, which are major components of wastewater. Another useful characteristic of microalgae is that they produce extracellular organic material which can then bind with dissolved metals, thereby reducing or eliminating metal toxicity. Microalgae can remove significant quantities of carbon, nitrogen, and phosphorus from wastewaters. The biochemical pathways responsible for the uptake and assimilation of these elements area interrelated, making it difficult to distinguish pathways which are specific for any one element. The pathways discussed in this paper include: (1) inorganic carbon uptake pathways; (2) nitrogen uptake pathways; and (3) phosphorus uptake pathways. Microalgae also appear to have the capability of degrading, adsorbing, or absorbing various pesticides, herbicides, and other xenobiotic organic compounds. It is still not clear whether algae can remove xenobiotics efficiently without significant deleterious effects on their growth capabilities, but the finding that microalgae can remove these sorts of agricultural wastewater contaminants is clearly important. Further studies, including the use of genetic engineering, may yield an algal species capable of efficient growth as well as significant removal of organic contaminants in drain waters. (See also W90-08141) (Lantz-PTT)
W90-08148

ALGAL CULTURE SYSTEMS.
Scripps Institution of Oceanography, La Jolla, CA. Marine Biology Research Div.
M. E. Huntley, A. M. Nonomura, and J. de la Noue.
IN: Biotreatment of Agricultural Wastewater. CRC Press, Inc., Boca Raton, Florida. 1989. p 111-130, 1 tab, 155 ref.

Descriptors: *Agricultural runoff, *Algae, *Biological treatment, *Culturing techniques, *Wastewater treatment, Agricultural chemicals, Biotechnology, Culturing, Farm wastes.

Algae possess a variety of physiological and metabolic adaptations which may be exploited to treat agricultural drainage. The principal advantage to using algae is that they can utilize solar energy and inorganic nutrients (which are usually in plentiful supply in drainage waters) for growth, whereas most bacteria require supplemental growth substrates in the form of organic compounds. However, even under the best of conditions, algae grow more slowly than bacteria; thus, larger culture volumes may be required. Open culture systems are likely to be most effective in limited circumstances where, for example, highly saline or alkaline influent waters are available; only under these specialized conditions will one be able to maintain a single species in culture. Open systems have two advantages: (1) they are relatively inexpensive to construct; and (2) more than 40 years of research and practical experience can be drawn upon to guide successful operation. A major disadvantage of open culture systems is that they must be custom built to the environment. Closed systems are likely to become increasingly important in the treatment of wastewaters due to their potential for containment and control of many different algal species. They have already proved to be conducive to higher growth rates, by a factor of two or three, than comparable open systems. Strain selection and genetic manipulation have the potential to increase specified metabolic activities applicable to wastewater treatment by additional factors of up to one order or magnitude. As these advances occur and as more experience is gained with the variety of culture methodologies (concentrated suspensions, hyperconcentrated suspensions, and immobilization), the cost of constructing and maintaining closed system technologies is likely to converge with that of open systems. (See also W90-08141) (Lantz-PTT)
W90-08149

ROLE OF MICROALGAE IN REMOVAL OF SELENATE FROM SUBSURFACE TILE DRAINAGE.
California Univ., Berkeley. Dept. of Civil Engineering.
W. J. Oswald, P. H. Chen, M. B. Gerhardt, F. B.

Green, and Y. Nurdogan.
IN: Biotreatment of Agricultural Wastewater.
CRC Press, Inc., Boca Raton, Florida. 1989. p 131-
141, 2 fig, 2 tab, 21 ref.

Descriptors: *Agricultural runoff, *Algae, *Bio-
logical treatment, *Selenium, *Wastewater treat-
ment, Agricultural chemicals, Fate of pollutants,
Microalgae, Selenate.

Selenium is a trace nutrient for microalgae and, as
such, there is some direct uptake. While some
algae are reported to contain relatively large
amounts of selenium after growing in selenium-
spiked waters, the kind of 'algae weeds' that grow
naturally in drainage water show only a small
uptake. To remove all selenium by direct uptake,
the algae would need to contain 0.12% selenium
rather than the 0.0005% selenium observed in pre-
vious studies. Concentrated waste-grown microal-
gal sludge originating from Richmond, CA sewage
and produced during methane fermentation has
been demonstrated to be a satisfactory reducing
material, since it converts soluble selenate in drain-
age waters to insoluble forms. Removal in 1:1
proportions and 12 h contact time exceeds 95%
when the influent Se concentrations is near 250
micrograms/L. The cost of microalgal sludge as a
reductant will mainly depend on the cost of ponds
and the productivity of the algae. Aside from their
use a reductant, algae have a number of unique
potential uses, such as raising the pH of the water
in which they are growing, and softening water by
precipitating $Ca(2+)$, $Mg (2+)$, and other polyva-
lent metals. Since this does not require the addition
of chemicals or the use of resins, it is an economi-
cal way of removing hardness ions and heavy
metals that interfere with reverse osmosis and dis-
tillation processes. (W90-08141) (Lantz-PTT)
W90-08150

ENGINEERING OF MICROALGAE MASS
CULTURE FOR TREATMENT OF AGRICUL-
TURAL WASTEWATER, WITH SPECIAL EM-
PHASIS ON SELENIUM REMOVAL FROM
DRAINAGE WATERS.
Technion - Israel Inst. of Tech., Haifa. Faculty of
Civil Engineering.
G. Shelef.
IN: Biotreatment of Agricultural Wastewater.
CRC Press, Inc., Boca Raton, Florida. 1989. p 143-
148, 1 fig, 5 ref.

Descriptors: *Agricultural runoff, *Algae, *Cost
analysis, *Economic aspects, *Selenium,
*Wastewater treatment, Agricultural chemicals,
Costs, Fate of pollutants.

Algal mass cultures high-rate ponds (HRPs) can be
used for the treatment of various agricultural
wastes, ranging from animal manures (cattle, poul-
try, piggeries, dairy cows, etc.) to agro-industrial
wastes (pineapple processing, fruit and vegetable
canning, etc.) to slaughterhouse and meat-packing
wastes and other organic wastes. The process
aimed at the removal of selenium at concentrations
ranging from 100 to 1400 (average 325) micro-
grams/L in raw subsurface tile agricultural drain-
age water to < 10 micrograms/L, consists of the
following features: (1) the algal high-rate pond
(HRP); (2) the anaerobic digester (AD); (3) the
reduction contact unit (RC); and (4) the dissolved
air flotation (DAF) unit (combined with filter). An
annual operating cost (including investment return)
of $1,110,000 (U.S., 1987) to treat 10 million gal-
lons per day (MGD) of subsurface tile drainage
waters for the removal of selenium to below 10
micrograms/L constitutes a cost of about $100/
acre-ft of drainage water. This is within the 'ball
park' of the costs which are feasible to farmers
(probably with some governmental subsidies),
ranging, according to the Bureau of Reclamation,
between $50 and $100/acre-ft (U.S., 1987). Econo-
my of scale should further reduce the costs when
larger schemes are built to remove selenium from
all the drainage waters in the affected area in the
San Joaquin Valley. The preliminary feasibility
analysis encourages bringing the microalgal/anaer-
obic bacterial process to a demonstration-scale fa-
cility (possibly with a 0.5 MGD flow) which will
provide more accurate engineering and cost pa-
rameters. (See also W90-08141) (Lantz-PTT)

W90-08151

IS THERE AN 'UNCERTAINTY PRINCIPLE'
IN MICROBIAL WASTE TREATMENT.
Tennessee Univ., Knoxville. Dept. of Chemical
Engineering.
J. W. Blackburn.
IN: Biotreatment of Agricultural Wastewater.
CRC Press, Inc., Boca Raton, Florida. 1989. p 149-
161, 2 fig, 1 tab, 35 ref.

Descriptors: *Microbial degradation, *Quality con-
trol, *Uncertainty, *Wastewater treatment, Biolog-
ical treatment, Biological wastewater treatment,
Performance evaluation, Technology.

Predictions of the performance and fate of chemi-
cals in mixed-culture microbial wastewater treat-
ment systems have been notoriously inexact. With
present methods and experimental protocols, un-
certainties in the structure and kinetics of processes
in mixed-culture microbial treatment exist. The
uncertainties, like the Heisenberg principle in phys-
ics, arise from the need to study a complex, undis-
turbed operating system and from the inability
(with present methods) to accomplish this without
disturbing the system. The complexity of the proc-
ess at the reactor, ecological, cellular, and molecu-
lar levels and interactions across these levels make
the system--for all practical purposes--indetermin-
ant. Unlike the Heisenberg principle, uncertainty in
microbial treatment systems can be reduced with
the development and application of new, emerging
molecular tools and the application and refinement
of systems analysis methods in conjunction with
the improved tools. Although considerably greater
effort will be required to successfully analyze these
systems than is presently being expended in the
development of biological waste treatment proc-
esses, improved understanding will lead to im-
proved predictability, better control schemes and
operability, and possibly, a new generation of ef-
fective biochemical treatment and production
processes based on controlled mixed-culture mi-
crobial systems. (See also W90-08141) (Lantz-
PTT)
W90-08152

SCREENING EQUIPMENT HANDBOOK: FOR
INDUSTRIAL AND MUNICIPAL WATER AND
WASTEWATER TREATMENT.
T. M. Pankratz.
Technomic Publishing Co., Inc., Lancaster, Penn-
sylvania. 1988. 266p.

Descriptors: *Handbooks, *Hydraulic equipment,
*Screens, *Wastewater treatment facilities, *Water
treatment, Corrosion control, Intakes, Physical
treatment.

The 'simplicity' of most screens is deceiving, and
their importance in overall plant performance is
usually underestimated. Tough operating require-
ments have resulted in many recent advances in
water and wastewater screening equipment, yet
some successful screen designs have gone almost
unchanged since the early 1900's. The selection of
the best screen for a specific application requires
careful attention and usually involves the consider-
ation of a number of engineering disciplines. Me-
chanical, civil, hydraulic, process, metallurgical
and electrical engineering questions must be an-
swered before the 'right' decision can be made.
This book is divided into sections describing the
major types of screening equipment. Sections 1, 2,
and 3 deal with those screens generally used for
raw water intakes. Section 4 covers screens pri-
marily used in wastewater treatment applications,
although trash rakes are also included in this sec-
tion because of their similarity to bar screens.
Section 5 covers fine screening, and Section 6
reviews microscreening in both water and
wastewater applications. Sections 7, 8, 9, and the
appendixes contain a variety of information that
should be of general interest, including: screen
control systems, selection of materials, and corro-
sion protection. (Lantz-PTT)
W90-08175

HANDBOOK: ESTIMATING SLUDGE MAN-
AGEMENT COSTS.

Environmental Protection Agency, Washington,
DC. Office of Research and Development.
Technomic Publishing Co., Inc., Lancaster, Penn-
sylvania. 540p, 138 fig, 18 tab, 3 append. EPA
Contracts 68-03-3017 and 68-01-6621.

Descriptors: *Cost analysis, *Sludge digestion,
*Sludge disposal, *Wastewater management,
*Wastewater treatment facilities, Economic as-
pects, Maintenance, Sludge thickening.

This manual provides preliminary cost estimating
curves, covering both capital costs and annual
operating and maintenance (O and M) costs, for
commonly used processes in municipal wastewater
sludge treatment, storage, transport, use, or dispos-
al. In addition, annual O and M component curves,
which provide additional user flexibility, are also
included. Curves are based on the cost algorithms
contained in Appendix A. The processes can be
readily arranged into various sludge management
chains and preliminary costs estimated for each
sludge management chain to be evaluated. Costs
presented are based on the last quarter of 1984, and
can be updated to later years by use of appropriate
cost indexes. An annotated bibliography of select-
ed literature containing sludge management cost
estimating information is included in Appendix B.
Appendix C provides commonly used English to
metric conversion factors. The cost curves provid-
ed generally cover a range up to 100 million gal-
lons of sludge per year, which is roughly equiva-
lent to a wastewater treatment plant capacity of at
least 50 million gallons per day (mgd). The range
selected includes plant sizes where it was consid-
ered that supplemental cost information might be
the most useful. By using the cost curves, the user
may obtain approximate capital and annual O and
M costs rapidly. Where applicable, a family of
curves is presented showing cost differentials as a
function of a significant sludge quality variable
(e.g., sludge suspended solids) or operational vari-
able (e.g., dry solids application rate). The cost
estimating algorithms, on the other hand, present a
logical series of calculations for inputting site-spe-
cific data for deriving base capital and base annual
operation and maintenance costs. (Author's ab-
stract)
W90-08176

STANDARD HANDBOOK OF ENVIRONMEN-
TAL ENGINEERING.
For primary bibliographic entry see Field 5G.
W90-08177

WASTEWATER DISPOSAL.
Post, Buckley, Schuh and Jernigan, Inc., Atlanta,
GA.
R. A. Corbitt.
IN: Standard Handbook of Environmental Engi-
neering. McGraw-Hill Publishing Co., New York,
New York. 1990. p 485-758, 135 fig, 148 tab, 94 ref.

Descriptors: *Biological wastewater treatment,
*Chemical treatment, *Wastewater disposal,
*Wastewater treatment facilities, Biological treat-
ment, Land disposal, Physical treatment, Sludge
treatment.

The process of water pollution control begins with
an understanding of the source and effect of
wastewater pollutants. The next step is to sample
and analyze the pollutant source(s). This character-
ization is then interpreted to forecast treatment
facility needs. The features of the existing and
proposed collection system must also be consid-
ered. Wastewater treatment plants are designed to
convert untreated liquid wastes into an acceptable
final effluent and to dispose of solids removed from
the process. In most cases, treatment is required for
suspended solids and for dissolved organics. Spe-
cial processes may be necessary to achieve remov-
al of a specific pollutant, such as phosphorus or
heavy metals. Wastewater treatment processes dis-
cussed in this chapter are: suspended solids treat-
ment, aerobic treatment, anaerobic digestion, bio-
logical treatment, land disposal, chemical treat-
ment, physical treatment, sludge treatment, and
wastewater treatment facilities. Typically, the re-
quired treatment processes produce sludges requir-

ing separate handling. Wastewater disposal is highly regulated and requires good cooperation between the owner, designer, and regulatory agencies. In addition, theory and practice must be balanced to provide a cost-effective and operable wastewater collection, treatment, and disposal system. (See also W90-08177) (Lantz-PTT)
W90-08182

STORMWATER MANAGEMENT.
Browne (F.X.) Associates, Inc., Lansdale, PA.
F. X. Browne.
IN: Standard Handbook of Environmental Engineering. McGraw-Hill Publishing Co., New York, New York. 1990. p 759-893, 48 fig, 50 tab, 113 ref.

Descriptors: *Management planning, *Storm runoff, *Storm water management, Economic aspects, Erosion control, Flood control, Flood peak, Legal aspects, Rainfall-runoff relationships, Storm-overflow sewers, Surface runoff.

The study of stormwater management includes all elements of the hydrologic cycle but focuses on how humans affect the production, movement, and control or surface runoff. In a natural system, the rate of surface runoff is controlled by the rainfall rate, soil conditions, vegetation, and subsurface geology. Most pollutants found in rainfall and stormwater runoff are removed from water as it soaks into the ground or flows through the organic litter at the soil surface. As urbanization occurs, large areas are covered by pavement and buildings. This results in large increases in the total quantity and peak rate of runoff. Pollutants deposited on pavements are washed directly into stream channels. Increases in surface runoff often result in more frequent flooding of near-channel areas and erosion of the streambanks. Modern stormwater management practices attempt to use natural and manmade systems to minimize environmental damage and provide the facilities necessary for modern society. A complete stormwater management program contains many elements including on-site infiltration and detention, collection and transport systems, regional flood control, and major stream channel improvements. It also includes a legal, financial, and institutional structure to implement the program. (See also W90-08177) (Lantz-PTT)
W90-08183

HAZARDOUS WASTE.
Post, Buckley, Schuh and Jernigan, Inc., Atlanta, GA.
R. A. Corbitt.
IN: Standard Handbook of Environmental Engineering. McGraw-Hill Publishing Co., New York, New York. 1990. p 1089-1213, 29 fig, 53 tab, 118 ref.

Descriptors: *Hazardous wastes, *Waste treatment, *Water pollution control, Cleanup operations, Heavy metals, Leakage, Pesticides, Radioactive wastes, Site remediation, Underground waste disposal.

Whether pesticides from agricultural lands, gasolines leakage from service station tanks, heavy metals from plating solutions, or radioactive wastes from nuclear powerplants, hazardous wastes are present throughout the world as byproducts of growth in developing nations. The technology for treatment and disposal of hazardous waste is the most rapidly developing area of environmental engineering. A significant portion of this technology is refinement and/or adaption of proven practices in air quality control, solid waste management, and wastewater treatment. Also, the environmental engineer must learn more about geohydrology to assess the subsurface disposition of hazardous wastes. In the United States, the management of hazardous waste is significantly regulated, including such requirements as a manifest system for waste tracking. In addition to a commitment to proper waste treatment and disposal, management programs need also to address means of waste reduction through industrial process changes, including recovery and reuse. This chapter addresses the general areas of direct hazardous waste treatment, categoric remedial action requirements, and

low-level radioactive waste handling, and the more specific area of abating underground storage tank leakage. (See also W90-08177) (Lantz-PTT)
W90-08184

INFLUENCE OF ALTERED ANTICORROSION TREATMENT ON THE MICROFLORA OF ACTIVATED SLUDGE IN PETROCHEMICAL PLANT EFFLUENT.
Durban-Westville Univ. (South Africa). Dept. of Microbiology.
C. G. Kahn, P. Stegmann, H. C. Kasan, and A. A. W. Baecker.
Water SA WASADV, Vol. 16, No. 1, p 23-28, January 1990. 3 fig, 1 tab, 24 ref.

Descriptors: *Activated sludge, *Biological wastewater treatment, *Chemical treatment, *Corrosion control, *Microorganisms, *Oil industry, *Wastewater treatment, Adaptation, Chlorophyta, Coal gasification, Fungi, Glucose, Growth media, Heterotrophic bacteria, Microbiological studies, Reclaimed water, Sludge lagoons, Species diversity, Yeasts, Zinc.

The microbiological populations of activated sludge treatment plants are generally diverse. However, the microorganisms in a given sludge basin constitute a community adapted to the particular wastewater treated. Representative samples from the fully aerated activated sludge basins of the water reclamation system of a zero-effluent coal gasification petrochemical plant were monitored before and after substitution of zinc chromate as anticorrosion agent. Fluctuations in the magnitude and metabolic activity of the microbiological population of the activated sludge during this period were quantified. The use of selective and enrichment media showed that fungi, yeasts, and green algae were present in insignificant numbers. Generalized counting media and a niche-simulating medium showed that the population of the activated sludge largely comprised heterotrophic bacteria representing a narrow range of genera, two filamentous microorganisms and one genus representing the cyanobacteria. The genus diversity of heterotrophic bacteria representing a narrow range of genera, two filamentous microorganisms and one genus representing the cyanobacteria. The genus diversity of heterotrophic bacteria increased after substitution of zinc acrylate for zinc chromate and glucose dehydrogenase activity of the sludge increased. Six weeks later genus diversity and dehydrogenase activity had returned to their initial status and it was suggested that the relatively simple population of microorganisms was susceptible to influence by changed anticorrosion agents but was also resilient; it acclimatized and returned to its initial status. (Author's abstract)
W90-08229

BIOLOGICAL EXCESS PHOSPHORUS REMOVAL: STEADY STATE PROCESS DESIGN.
Cape Town Univ. (South Africa). Dept. of Civil Engineering.
M. C. Wentzel, G. A. Ekama, P. L. Dold, and G. R. Marais.
Water SA WASADV, Vol. 16, No. 1, p 29-48, January 1990. 17 fig, 4 tab, 11 ref, append.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Phosphorus removal, *Wastewater treatment, Biodegradation, Continuous flow, Culturing techniques, Design standards, Fatty acids, Influent streams, Kinetics, Municipal wastes, Phosphorus, Substrates.

Designs of activated sludge systems to accomplish biological excess phosphorus (P) removal still are based on experience and semi-empirical methods. The need exists for design procedures based on more fundamental behavioral patterns and kinetics. Recently, a model describing the kinetic behavior of enhanced cultures of the organisms mediating biological excess P removal (generically termed polyP organisms) was developed. From this kinetic model, design equations were developed to determine the release, uptake, and removal of P in modified Bardenpho and UCT systems under constant flow and load conditions. Knowing the influent COD and TKN concentrations, for specified

sludge age and anaerobic mass fraction, the fraction of influent readily biodegradable COD converted to short-chain fatty acids by the non-polyP organisms (and the associated P release to sequester the short-chain fatty acids), was calculated. In this manner the influent substrate fractions available to the polyP and non-polyP organisms were determined, and the respective masses of organisms generated from the substrate were calculated. From the mass of sludge wasted per day, the concentration of P removed from the influent was calculated. The calculated P removal correlates well with the removal observed in laboratory-scale systems treating municipal waste flows, over wide ranges of sludge ages and influent characteristics. (Author's abstract)
W90-08230

EVALUATION OF THE METHODS USED FOR THE DETERMINATION OF ORTHOPHOSPHATE AND TOTAL PHOSPHATE IN ACTIVATED SLUDGE EXTRACTS.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
D. W. Haas, L. H. Lotter, and I. A. Dubery.
Water SA WASADV, Vol. 16, No. 1, p 55-65, January 1990. 4 fig, 5 tab, 27 ref.

Descriptors: *Activated sludge process, *Laboratory methods, *Orthophosphates, *Phosphates, *Wastewater analysis, *Wastewater facilities, *Wastewater treatment, Acidity, Biological wastewater treatment, Chromatography, Error analysis, Ionic interference, Performance evaluation, Phosphorus removal, Sludge digestion, Turbidity.

A need exists for routine analysis of the phosphorus fractions stored in activated sludge from wastewater treatment plants designed to accomplish biological phosphate removal. An investigation was conducted into the suitability of published methods for orthophosphate and total phosphate determinations when applied to extracts of activated sludge or artificial solutions simulating such extracts. It was found that the standard orthophosphate method for water could be used, but attempts to increase its range are likely to introduce errors due to turbidity formation, especially with samples at high ionic strength. The standard persulphate digestion procedure for total phosphate (TP) was found to give slightly inferior recoveries from activated sludge samples relative to a procedure in which the acid and persulphate concentrations were raised. A post-digestion dilution is necessary to avoid interferences in the subsequent orthophosphate determination due to the higher ionic strength and acidity of the digest. Negative interference is caused by acid-hydrolysable phosphates at high concentrations in the standard molybdate-ascorbic acid orthophosphate determination. Determination of orthophosphate in the presence of relatively large concentrations of polyphosphates may therefore be subject to significant errors. It is advisable to use a modified method for orthophosphate determination which reduces these errors and to check the result by gel chromatography. (Author's abstract)
W90-08232

SOME CONSIDERATIONS IN POLYPHOSPHATE DETERMINATIONS OF ACTIVATED SLUDGE EXTRACTS.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
D. W. de Haas, L. H. Lotter, and I. A. Dubery.
Water SA WASADV, Vol. 16, No. 1, p 67-74, January 1990. 2 fig, 4 tab, 25 ref.

Descriptors: *Activated sludge process, *Biological wastewater treatment, *Phosphates, *Phosphorus removal, *Wastewater analysis, *Wastewater facilities, *Wastewater treatment, Acidification, Acidity, Activated carbon, Adsorption, Colorimetry, Hydrogen ion concentration, Ions, Laboratory methods, Nucleic acids, Performance evaluation, Sugars.

A need exists for routine analysis of the phosphorus fractions stored in activated sludge from

wastewater treatment plants designed to accomplish biological phosphate removal. An investigation was conducted into the suitability of published methods for polyphosphate determinations when applied to extracts of activated sludge or artificial solutions simulating such extracts. It was found that powdered activated carbon (PAC) in stirred batch systems may be used selectively to remove nucleic acids from mixtures with polyphosphates, but simultaneous polyphosphate adsorption occurs in weakly ionic environments at acidic, neutral, or basic pH. The addition of 1% (m/v) trichloroacetic acid (TCA) and 0.5 M perchloric acid, or the sodium salts of these acids, served to abolish the adsorption of polyphosphate (Graham's salt, n=16) at acidic, neutral, or basic pH. Moreover, the adsorption of nucleic acids to PAC is enhanced by 1% TCA at neutral to basic pH. A convenient method for washing PAC free of phosphate involves hot acid-persulphate treatment, followed by hot dilute acid and hot distilled water treatment. It seems advisable to check nucleic acid removal using colorimetric methods based on sugar determinations, and hence to estimate polyphosphate adsorption by difference with total phosphate results. (Author's abstract)
W90-08233

FUNDAMENTALS OF FLOCCULATION.
University Coll., London (England). Dept. of Civil Engineering.
J. Gregory.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 3, p 185-230, 1989. 15 fig, 131 ref.

Descriptors: *Aggregates, *Chemical coagulation, *Flocculation, *Reviews, *Wastewater treatment, Colloids, Inorganic compounds, Kinetics, Particulate matter, Physicochemical properties, Polymers, Separation techniques.

Flocculation is an important step in many solid-liquid separation processes and is widely used in water and wastewater treatment. Common unit operations such as filtration, flotation, and sedimentation become more effective as the size of the particles is increased. Flocculation occurs only if particles collide with each other (transport) and can adhere when brought together by collision (attachment). In this review, colloid interactions are first discussed, including general, van der Walls, electrical and combined interactions. Hydration effects, hydrophobic interaction, and polymer bridging are other important transport mechanisms defined. An examination is made of the kinetics of flocculation, covering collision frequency and floc size and form. The most commonly used inorganic flocculants, especially in the water and wastewater treatment areas, are iron and aluminum compounds. Al and Fe salts are also able to remove dissolved organic matter, especially high molecular weight materials such as humic substances. Many types of polymeric flocculants are also available, such as: (1) nonionic--polyvinyl alcohol, polyethylene oxide; (2) anionic--sodium polystyrene sulfonates; and (3) cationic--polyethyleneimine. (VerNooy-PTT)
W90-08236

EFFECT OF IRON ON ANAEROBIC DIGESTION.
Rhodes Univ., Grahamstown (South Africa). Dept. of Chemistry and Biochemistry.
C. A. Jackson-Moss, and J. R. Duncan.
Biotechnology Letters BILED3, Vol. 12, No. 2, p 149-154, February 1990. 3 fig, 3 tab, 12 ref.

Descriptors: *Anaerobic digestion, *Iron, *Methanogenesis, *Wastewater treatment, Bacteria, Biogas, Sludge.

The ability of methanogenic bacteria to adapt to high concentrations of iron was investigated using a 9 L Upflow Anaerobic Sludge Blanket (UASB) reactor fed semi-continuously with a synthetic waste containing glucose as the organic carbon source. It was found that an iron concentration of up to 5,650 mg/L, which is well in excess of previously reported toxicity levels, had no inhibitory effects on anaerobic digestion, with the excep-

tion of a decrease in biogas production. The iron precipitated out and accumulated in the sludge bed of the digester, resulting in very low concentrations of iron in the digester effluent. (Author's abstract)
W90-08261

EVOLUTION OF MICROBIAL ACTIVITIES AND POPULATION IN GRANULAR SLUDGE FROM AN UASB REACTOR.
Universidad Autonoma Metropolitana, Mexico City. Unidad Iztapalapa.
J. P. Guyot, A. Noyola, and O. Monroy.
Biotechnology Letters BILED3, Vol. 12, No. 2, p 155-160, February 1990. 2 fig, 3 tab, 17 ref. EEC Grant C11.0197.Mexico (H).

Descriptors: *Anaerobic digestion, *Microbiological studies, *Volatile solids, *Wastewater treatment, Bacteria, Methanogenesis, Sludge.

With granular sludges grown in a upflow anaerobic sludge blanket (UASB) reactor fed with a mixture of acetate propionate, it was shown that the growth of propionate-utilizing bacteria was responsible for the increase of the volatile suspended solids (VSS) content of the granular sludge; acetoclastic microflora grew little if at all. There was no stoichiometric relationship between substrate removal and observed methane production. Contrary to the common practice, the best way to present data on bacterial concentrations in sludges is bacteria/g VSS, which will provide a reliable basis for comparisons between different works from various authors. (Author's abstract)
W90-08262

NITROUS ACID-INITIATED OXIDATIVE STRESS IN SOME GREEN ALGAE.
Bulgarian Academy of Sciences, Sofia. Inst. po Fiziologiya na Rasteniyata.
K. M. Benderliev, and N. I. Ivanova.
Khidrobiologia KHIDD9, Vol. 35, p 33-39, 1990. 3 fig, 3 tab, 7 ref.

Descriptors: *Algal growth, *Biological wastewater treatment, *Chlorophyta, *Nitrogen compounds, *Oxidation, *Wastewater treatment, Algae, Chelating agents, Iron compounds, Nitrous acid, Oxidation process, Scenedesmus.

Oxidative stress initiated by nitrous acid was investigated in the green algae Scenedesmus incrassatulus and Scenedesmus acutus. Linear growth phase cells in media with varying amounts of nitrous acid were aerated at 100 liters per hour at 29 C under continuous illumination. The growth coefficients of S. acutus and S. incrassatulus exhibited differences in the length of the comparative tolerance zone for nitrous acid. Underdosing or overdosing of the chelator ethylenediaminetetraacetic acid (EDTA) and iron sulfate also inhibited cell growth by enhancing peroxidation processes. The imbalance of iron or EDTA induced lipid, carbohydrate, and pigment diminution, and enhancement of thiobarbituric reacting matter. Rust was also found to inhibit algal cell growth. Intense cultivation conditions accelerated the release of non-chelated iron from EDTA-iron complexes. The authors conclude that algal cultivation in the treatment of waste waters may be sensitive to denitrification, algal nitrite excretion, and excess iron corrosion products in open-field algal ponds. (MacKeen-PTT)
W90-08293

ON-LINE FAILURE ANALYSIS OF A BIOGAS PLANT BY A TRACER TEST.
Lund Univ. (Sweden). Dept. of Chemical Engineering.
B. K. Nilsson, and H. T. Karlsson.
Chemie-Ingenieur-Technik CITEAH, Vol. 62, No. 2, p 124-125, February 1990. 2 fig, 1 tab, 2 ref.

Descriptors: *Biogas, *Digester gas, *Lithium, *Methane, *Methanogenesis, *Tracers, *Waste treatment, Biofilm reactors, Least squares method, Manure, Rheology, Scaling, Sweden.

A farm-scale biogas plant was constructed in 1981 for generation of methane from manure at a farm

in southern Sweden. After four years of smooth operation, a dramatic decrease in gas production was observed. In order to prevent wash-out of microorganisms from the reactor, the feeding rate was substantially decreased, causing a dramatic change in the rheological properties of the manure, which in turn caused sediments to build up in the reactor, thus decreasing the active reactive volume. A tracer test was used as a diagnostic tool to identify the on-line problem without having to shut down the reactor. Lithium was selected as tracer, because it is easy to analyze and does not interact with the microbial activity, and was introduced as a pulse input to the digester. After proper mixing, samples were withdrawn from the digester effluent over a 65-day period. The concentration of lithium was plotted as a function of time, and it was found that the data points complied with a logarithmic evaluation equation. By evaluating the slope and the intercept of the least-squares fitted curve, it was possible to estimate the actual reaction volume in two independent ways, which yielded approximately the same values. The reaction volume was shown to be 57 to 60% of the designed volume. The result was clearly sufficient to warrant a shutdown of the digester for manual inspection, where it was found that the reactor was covered with a soft scale of sediment and a crust of solids, occupying a total of roughly 40% of the reactor volume, in good agreement with the result of the tracer test. The solids were removed and the mixing system redesigned for the actual rheological properties of the manure. (Fish-PTT)
W90-08322

STOCHASTIC SYSTEM IDENTIFICATION OF SEWER-FLOW MODELS.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
A. G. Capodaglio, S. Zheng, V. Novotny, and X. Feng.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 284-298, March/April 1990. 8 fig, 5 tab, 16 ref.

Descriptors: *Combined sewer overflows, *Model studies, *Rainfall-runoff relationships, *Sewer systems, *Sewers, *Stochastic models, *Urban hydrology, Flow discharge, Italy, Pollution load, Surface water.

Modeling of sewer flow and quality is essential for real-time control of sewer systems and minimization of combined sewer overflows (CSO). Studies have shown that CSOs contribute substantially to the overall pollution loads discharged into surface-water bodies. A modeling strategy based on system identification analysis of single-input, single-output stochastic processes is presented. An application example is illustrated using the flow and rainfall time series observed in the collection system discharging to the treatment plant of Fusina, Italy. The advantages of this type of modeling strategy, compared with a traditional deterministic model, are the relative simplicity of the model, its requirement for a minimal amount of investigation to describe the physical system, and the possibility of continuous updates of the model as the system data base expands. Furthermore, stochastic models are able to reflect truly the dynamic features of the system under investigation and allow the prediction of its future behavior with a specified degree of confidence. (Author's abstract)
W90-08344

COLLOID FILTRATION IN FLUIDIZED BEDS.
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA.
G. Sprouse, and B. E. Rittmann.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 299-313, March/April 1990. 5 fig, 5 tab, 23 ref. National Science Foundation Grant No. ECE-835 1833.

Descriptors: *Biofilms, *Biological wastewater treatment, *Colloids, *Filtration, *Fluidized bed process, *Wastewater treatment, Diffusion, Flow velocity, Interception, Mechanical control, Sedi-

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ment transport, Sedimentation, Suspended sediments.

Particle transport and capture are essential for the successful treatment by fluidized bed biofilm processes of wastewaters containing suspended organic matter. Small-scale, once-through, fluidized bed filters were utilized to analyze the transport mechanisms and effects of collector surface chemistry on the removal of ferric-hydroxide flocs by fluidized granular activated carbon collectors. Experimental results demonstrated that the mechanisms of diffusion, gravity sedimentation, and interception acted according to theory to provide particle transport to the surface; that gravity sedimentation was the dominant mechanism under the conditions studied and was not affected by the upward water velocity; that the inertial mechanism was unimportant; that not having strictly laminar conditions did not invalidate use of the mechanistic model; and that expansion of the bed by greater superficial flow velocities caused suspended particle removal efficiencies to decline. (See also W90-08345) (Author's abstract)
W90-08345

COLLOID REMOVAL IN FLUIDIZED-BED BIOFILM REACTOR.
Montgomery (James M.) Consulting Engineers, Inc., Pasadena, CA.
G. Sprouse, and B. E. Rittmann.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 314-329, March/April 1990. 8 fig, 6 tab, 15 ref. National Science Foundation Grant No. ECE-835 1833.

Descriptors: *Biofilms, *Biological wastewater treatment, *Colloids, *Filtration, *Fluidized bed process, *Model studies, *Wastewater treatment, Chemical oxygen demand, Cohesion, Methanogenesis, Model testing, Organic compounds, Organic loading, Suspended sediments.

Many wastewaters contain appreciable amounts of organic particles. A methanogenic fluidized-bed biofilm reactor was successfully operated for the removal of 1-micrometer organic colloids. The removal efficiency of total suspended solids was 72-76%, and the total chemical oxygen demand removal was 91-93%. Since some of the effluent suspended solids were biomass, the actual removal efficiency of the original organic particles was approximately 90%. Mechanistic filtration theory was modified to include bed fluidization, biofilm attachment to the collector surface, and effluent recycle. Independent filtration experiments showed that biofilm accumulation increased the cohesion coefficient from zero to 0.04. The predictions using a measured cohesion coefficiency of 0.04 agreed with the findings from the methanogenic system: removal of input suspended solids was 90% at 31% bed expansion; the recycle of effluent was an important determinant of the ability of the fluidized-bed system effectively to filter the particle material; and, for the organic loading conditions of this study, the removal of organic particles did not vary with changes in the expansion of the bed. However, the modeling also predicted that increases in influent particle concentration should allow better overall particle mass removals for the same mass loading. (See also W90-08344) (Author's abstract)
W90-08346

VIABILITY OF ANAEROBIC DIGESTER SLUDGE.
Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea).
Y.-C. Chung, and J. B. Neethling.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 330-342, March/April 1990. 7 fig, 4 tab, 19 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Biomass, *Sludge digestion, *Wastewater treatment, Adenosine triphosphate, Primary sludge, Suspended solids, Volatile solids, Wastewater facilities.

Anaerobic sludge digestion is the most popular method used to stabilize primary sludge in

wastewater treatment plants by converting volatile solids to gaseous end-products. Since successful operation of this biological process depends on maintaining a careful balance in the system ecology, it is important to be able to measure the viable biomass in the system. The viability of biological sludges is commonly expressed as the active bacterial concentration per unit mass volatile suspended solids (VSS). Due to the high concentration of particulate matter in anaerobic sludge digester feed, digester volatile solids contain a large concentration of nonbacterial mass. Viability of anaerobic sludge based on sludge digester total VSS will therefore underestimate the active mass. Based on adenosine triphosphate (ATP) measurements, only 5 to 10% of the total VSS represents active bacterial biomass. Bacterial viability based on the biomass VSS fraction in the anaerobic sludge digester is much higher than viabilities based on total VSS. Using a kinetic model of anaerobic sludge digestion, the biomass VSS can be estimated. For sludge ages exceeding 10 days, less than 20% of the total volatile solids represents biomass; the remainder consists of biodegradable VSS not yet hydrolyzed for bacterial uptake and inert VSS. This means that 40 to 50% of the biomass VSS in anaerobic sludge represents active biomass. Based on ATP, anaerobic sludge viability ranges from 0.76 to 0.99 mg ATP/g biomass VSS for sludge ages between 10 and 40 days, which is comparable to reported aerobic sludge activity measurements. (Author's abstract)
W90-08347

ASSESSING POLYELECTROLYTE BEHAVIOR BY SIZE-EXCLUSION CHROMATOGRAPHY.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
R. Gehr, and T. Soponkanaporn.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 343-360, March/April 1990. 12 fig, 38 ref.

Descriptors: *Chromatography, *Polyelectrolytes, *Wastewater treatment, *Water analysis, *Water treatment, Cations, Chlorination, Chlorine, Chloroform, Flocculation, Ozone.

Size-exclusion chromatography (SEC) is used to investigate the behavior of polyelectrolytes during sewage and water treatment processes. Sewage treatment is modeled by jar tests on raw sewage. Beyond the optimum polyelectrolyte dose for turbidity removal of 2 mg/L, SEC is able to detect residual polyelectrolytes in the supernatant. It is also possible to show by SEC measurements that higher molecular weight (MW) fractions of cationic polyelectrolytes are adsorbed to the solids proportionally more than the lower MW fractions; however, with anionic polyelectrolytes there is no similar selection. In the case of water treatment, SEC is used to investigate the interaction of polyelectrolytes with chlorine and ozone. In both cases, there is a shift to lower MW products, and this could be related to a reduction in flocculation efficiency of the polyelectrolyte. The production of acrylamide and chloroform during chlorine and ozone interaction with the polyelectrolyte is also monitored. Acrylamide monomer concentration is reduced by both chlorine and ozone. Chloroform is produced in significant concentrations during chlorination (yield of 0.019 mg/mg at pH 9 after three days). SEC can be thus used for detection, monitoring, and control; to study the behavior of polyelectrolytes; and finally, to predict the flocculation efficiency of existing polyelectrolytes. (Author's abstract)
W90-08348

NEW COST-EFFECTIVE APPROACH TO NUTRIENT REMOVAL.
Hampton Roads Sanitation District, Norfolk, VA.
J. R. Borberg, L. M. Morales, and G. T. Daigger.
Public Works PUWOAH, Vol. 121, No. 4, p 54-55, April 1990. 4 fig.

Descriptors: *Nutrient removal, *Secondary wastewater treatment, *Wastewater facilities, *Wastewater treatment, Biological wastewater treatment, Cost analysis, Virginia.

A new technology (the Virginia Initiative plant process or VIP process) for municipal wastewater treatment produces a high quality secondary effluent and consistently removes about 75% of the nitrogen and 65% of the phosphorus, at capital costs that are only about five % greater than the costs of conventional secondary treatment, and at operating costs that are about the same. The VIP process provides this cost-effective treatment because it does not rely on the chemical additives and unit process 'add-ons' that are used by advanced wastewater treatment (AWT) systems for nutrient removal. VIP can offer these cost advantages over AWT: (1) The VIP process uses influent wastewater as the food source to achieve nitrogen removal in the anoxic zone; (2) The VIP process does not generate chemical sludges like AWT systems because the process is biologically, rather than chemically, based; (3) Capital costs are lower because the VIP process accomplishes nutrient removal in a single facility; (4) The VIP process requires less aeration and thus reduces energy costs; (5) The VIP process provides municipal wastewater utility managers with a new tool for meeting increasingly stringent discharge standards while controlling the cost impact on utility ratepayers. (Chonka-PTT)
W90-08375

MASS TRANSFER MECHANISM IN A POROUS RIVERBED.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
For primary bibliographic entry see Field 2E.
W90-08382

REACTIONS OF FREE CHLORINE WITH SUBSTITUTED ANILINES IN AQUEOUS SOLUTION AND ON GRANULAR ACTIVATED CARBON.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-08383

REMOVAL OF CU(II) FROM DILUTE AQUEOUS SOLUTIONS BY SACCHAROMYCES CEREVISIAE.
Delaware Univ., Newark. Dept. of Civil Engineering.
C. P. Huang, C. P. Huang, and A. L. Morehart.
Water Research WATRAG, Vol. 24, No. 4, p 433-439, April 1990. 10 fig, 1 tab, 33 ref. USGS Grant 14-08-0001-G1292.

Descriptors: *Biological wastewater treatment, *Biotechnology, *Copper, *Heavy metals, *Wastewater treatment, *Yeasts, Adsorption, Biosorption, Metals.

Biosorption of Cu(II) from dilute solution by virgin or treated unicellular yeast, Saccharomyces cerevisiae, was studied. Cu(II) adsorption is strongly affected by pH. A given amount of protein is released from live cells upon interactions with metal ions. This decreases the amount of Cu(II) adsorption and is most pronounced at high pH values. Adsorption takes place on multisites and can be analyzed by Scatchard plots. Cu(II) uptake by live yeast was biphasic and consisted of an initial, rapid surface binding of Cu(II) followed by a second, slower intracellular uptake of Cu(II). Cu(II) uptake by dead yeast and Cu(II), Pb(II) uptake by live yeast takes place only via surface binding. In a total of 30 micromol/g Cu(II) uptake by live yeast, 7 micromol/g can be attributed to intracellular uptake. A sand column with immobilized S. cerevisiae can completely remove metals before the breakpoint. After the breakpoint, a significant amount of Cu(II) removal over a long period was observed. This is thought to be the result of intracellular uptake. Strong acid can be used to strip the Cu(II)-laden column for reuse. The result shows that a Cu(II)-laden column can be stripped of adsorbed Cu(II) with one volume of acid (HClO4) per 20 volumes of Cu(II) containing acid. (Author's abstract)
W90-08384

EFFECT OF BIOLOGICAL TREATMENTS ON COD ADSORPTION.

General Motors Research Labs., Warren, MI. Environmental Science Dept.
B. R. Kim, S. G. Anderson, and J. F. Zemla.
Water Research WATRAG, Vol. 24, No. 4, p 457-461, April 1990. 4 fig, 2 tab, 16 ref.

Descriptors: *Aerobic treatment, *Anaerobic digestion, *Biological wastewater treatment, *Chemical oxygen demand, *Industrial wastewater, *Wastewater treatment, Activated carbon, Adsorption, Biodegradation, Isotherms, Sludge.

A simulated wastewater, which contains eight metal cutting fluids, was treated using three biological schemes: anaerobic, anaerobic followed by aerobic and aerobic. Sludge ages for the biological schemes were sufficiently long to produce effluents in which the residual organics were practically nonbiodegradable. Adsorption isotherms, obtained using the wastewater and the three biologically treated effluents, revealed that the absorption capacity of activated carbon increased substantially after the wastewater was biologically treated. The increase appeared to be due to selective, biological removal of poorly adsorbable organics, displaying a synergistic relationship between adsorption and biodegradation. The organic compositions in the anaerobic/aerobic effluent and in the aerobic effluent might be similar because the adsorption isotherms for the effluents were virtually identical. (Author's abstract)
W90-08388

LOW TEMPERATURE TREATMENT OF MUNICIPAL SEWAGE IN ANAEROBIC FLUIDIZED BED REACTORS.

Valladolid Univ. (Spain). Dept. of Chemical Engineering.
I. Sanz, and F. Fdz-Polanco.
Water Research WATRAG, Vol. 24, No. 4, p 463-469, April 1990. 8 fig, 5 tab, 11 ref.

Descriptors: *Anaerobic digestion, *Biological wastewater treatment, *Municipal wastewater, *Raw wastewater, *Temperature effects, *Wastewater treatment, Fluidized bed process, Low temperature treatment, Suspended solids.

The anaerobic fluidized bed reactor (AFBR) appears to be most promising for the treatment of low strength wastes, such as municipal sewage, at low temperature, since the process is able to maintain a large mass of active microorganisms and provides effective removal of total suspended solids (TSS). The study is divided in three parts: (1) characterization of the effect of decreasing temperature on the performance of two mature AFBR reactors; (2) presentation of the data from 220 days of operation at 10 C; (3) evaluation of two start-ups, with and without inoculum at 15 C. A gradual temperature decrease from 20 to 5 C, allowing the microorganisms to acclimate to the new lower temperature, did not have a great effect on effluent quality. However, a great accumulation of TSS was observed in the top of the fluidized bed. At 10 degrees C, and a hydraulic retention time of 1.5 hours, 70% of total chemical oxygen demand removal was achieved. It is possible to start-up the AFBR at 15 C without inoculation; however, at least 4 months is required to get good quality effluents. (Author's abstract)
W90-08389

SURVEY OF FILAMENTOUS BACTERIAL POPULATIONS FROM FOAMING ACTIVATED SLUDGE PLANTS IN EASTERN STATES OF AUSTRALIA.

Bendigo Water Board (Australia).
E. M. Seviour, C. J. Williams, R. J. Seviour, J. A. Soddell, and K. C. Lindrea.
Water Research WATRAG, Vol. 24, No. 4, p 493-498, April 1990. 6 fig, 4 tab, 14 ref.

Descriptors: *Activated sludge, *Australia, *Bacterial analysis, *Filamentous bacteria, *Wastewater treatment, Foaming, Scum.

Of 129 activated sludge plants surveyed during 1988 in Queensland, New South Wales and Victo-

ria, 66 had a foam problem during the sampling period. Filament identification revealed that Microthrix parvicella, Nocardia amarae and Nocardia pimensis were the most commonly found, followed by Eikelboom types 0092, 0914, and 0041/0675. Although their relative frequencies varied from state to state. Evidence supports the view that foaming can be an intermittent and unpredictable problem. Until large numbers of these isolates, particularly the Eikelboom types, from many different plants are successfully cultured, characterized and then compared, and their autecology understood, any control measures based in unfounded empirical engineering approaches are unlikely to be successful, except in the short term. (Chonka-PTT)
W90-08393

NITRIFICATION IN ROTATING DISC SYSTEMS: II. CRITERIA FOR SIMULTANEOUS MINERALIZATION AND NITRIFICATION.

Technical Univ. of Istanbul (Turkey). Dept. of Environmental Engineering.
E. Gonenc, and P. Harremoes.
Water Research WATRAG, Vol. 24, No. 4, p 499-505, April 1990. 3 fig, 1 tab, 43 ref.

Descriptors: *Biofilm reactors, *Biological wastewater treatment, *Mineralization, *Nitrification, *Wastewater treatment, Bacteria, Kinetics.

The criteria for nitrification and correction of the nitrification rate in the presence of mineralization are presented on the basis of biofilm kinetics for triple substrate conditions (soluble organic matter, ammonia and oxygen) in a rotating disc system. To verify the theoretical criteria, data from the literature were used. The ratio between bulk soluble BOD_5 and oxygen concentrations should be less than five for achieving simultaneous (nitrification criterion). For simultaneous mineralization and nitrification in the system, the nitrification rate must be reduced compared to pure nitrification by two factors, namely the mixture and distribution of heterotrophs and nitrifiers within the biofilm, and oxygen penetration into the biofilm to allow the growth of nitrifiers. Accordingly the reduction becomes a function of the growth yield of the two bacteria types, removal of each soluble substrate and the diffusion coefficients. (Author's abstract)
W90-08394

CARBON FLOW IN ACETOTROPHIC ENRICHMENT CULTURES FROM PULP MILL EFFLUENT TREATMENT.

Tampere Univ. of Technology (Finland). Inst. of Water and Environmental Engineering.
J. A. Puhakka, M. Salkinoja-Salonen, J. F. Ferguson, and M. M. Benjamin.
Water Research WATRAG, Vol. 24, No. 4, p 515-519, April 1990. 2 fig, 3 tab, 16 ref.

Descriptors: *Anaerobic digestion, *Methane bacteria, *Methanogenesis, *Pulp wastes, *Sludge, *Sulfates, *Wastewater treatment, Acetates, Culturing techniques, Industrial wastewater, Sulfides, Toxicity.

Anaerobic acetate utilizing cultures were enriched from three different environments of pulp mill wastewater and subsequently subcultured on calcium acetate and calcium acetate plus sodium sulfate media. Microbial acetate conversion was complete in all cases where methanogens tolerant to sulfur compounds were present, even at 4.6 g $SO4(2+)$/ L. Acetate coversion by sulfate reduction was significant only in methanogenic cultures sensitive to sodium sulfate or its metabolic products. Sulfate reduction was always incomplete although acetate was present in excess. Sulfate reducing capacity persisted in continuous cultivation of sludge for at least 2 years in the absence of oxidized sulfur compounds. Tolerance of acetotrophic methane-producing bacteria from pulp mill wastewater sludge towards sulfur compounds (sulfate plus its metabolites) was preserved beyond an experimental exposure of 6 months (6 transfers) to acetate-only medium. Another methanogenic enrichment culture from pulp mill sludge developed sensitivity towards sulfur compounds after being continuously cultured in an environment lacking oxidized sulfur compounds for 2 years. (Author's abstract)

W90-08396

OZONATION OF SEVERAL ORGANIC COMPOUNDS HAVING LOW MOLECULAR WEIGHT UNDER ULTRAVIOLET IRRADIATION.

National Research Inst. for Pollution and Resources, Yatabe (Japan).
N. Takahashi.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 1, p 1-18, 1990. 7 fig, 1 tab, 17 ref.

Descriptors: *Ozonation, *Ultraviolet radiation, *Wastewater treatment, *Water treatment, Carboxylic acid, Chemical analysis, Irradiation, Organic compounds, Phenols, Total organic carbon.

Ozone reacts selectively with organic compounds, and usually cannot decompose them completely to carbon dioxide and water. Consequently, organic compounds, such as carboxylic acids, remain in solution after ozonation. Many methods have been tried to overcome this characteristic, and the simultaneous use of ozone and ultraviolet (UV) irradiation (abbreviated as the O3/UV method) is one of these methods. This technique does not utilize ozone directly, but instead utilizes reactive species produced during the decomposition process of ozone by UV irradiation. Phenol and its reaction products were analyzed by means of high performance liquid chromatography (HPLC). Nine compounds were identified as reaction products of the ozonation of phenol; the major products were: glyoxal, glyoxylic acid, oxalic acid, and formic acid. The ozonation of phenol was promoted by the simultaneous use of ozone and UV irradiation. However, the synergistic effect decreased as the concentration of phenol increased. The high removal of total organic carbon (TOC) was attained with organic compounds having carbon numbers from 1 to 6, after 3.0 hours. The rate of removal of TOC in the same compound group decreased with increase of molecular weight. No difference between TOC removals was observed with an aldehyde, alcohol, and carboxylic acid having the same carbon number. The removal of TOC by the O3/UV method was higher than those by both the O3 and UV methods. Organic compounds having lower molecular weights were decomposed completely to CO2 and water. These facts confirm that the O3/UV method is very effective for the ozonation of organic compounds having low molecular weights. Moreover, considering that there is no need for the addition of salts and chemicals, this method seems to be suitable as an advanced treatment method. (Agostine-PTT)
W90-08453

CHROMATE IN INDUSTRIAL EFFLUENTS: THE ACTIMAG METHOD OF REDUCTION.

P. Bowden.
Water & Waste Treatment Journal WWTJAA, Vol. 32, No. 7, p 21-28, July 1989. 6 fig.

Descriptors: *Actimag process, *Chromium, *Industrial wastewater, *Metal-finishing wastes, *Wastewater treatment, Operating costs.

Concern with the levels of metal contamination in industrial wastes has focussed attention on methods of removing chromium from effluents and rinse waters discharged by metal finishing and surface treatment plants using chromic acid or chromate salts. The Actimag process is a low cost technique for reducing Cr(VI) levels to below detectable limits (<0.05 ppm), facilitating complete removal as chromic hydroxide in subsequent treatment. The process was originally developed for the extraction or recovery of precious metals from solution, but it became apparent that the same technique could be applied to other reactions, in particular the chromate reaction. The reactor in the Actimag process consists of a vertical tube containing a charge of iron shots. Chrome laden solution is pumped through a fluidized valve at the base of the reactor creating a fluidized bed of iron shots. A set of externally mounted electromagnets creates a variable magnetic field across the reactor. Three effects result from the application of the field, all tending to increase the kinetics of the reaction: (1)

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The velocity of the iron shots and the ionic species $CrO4(2-)$ or $Cr2O7(2-)$ are greatly increased relative to the solution. (2) There is a substantial increase in the number and force of collisions between iron particles, cleaning the metal surface of any reaction products which could have a passivating effect. (3) An electromotive force is induced in the iron particles as the field pulses. Indications are that emf values of 10-100 mV could be found and these charges may have a marked electrochemical effect, 'activating' any reactions occurring. Advantages of the Actimag process over the commonly used bisulfite method include lower operating and maintenance costs, space saving, ease of control, improved safety, lower sulfate emissions, and ease of precipitation. (Sand-PTT) W90-08469

WATER, WASTEWATER, AND SLUDGE FILTRATION.
CRC Press, Inc., Boca Raton, Florida. 1989. 281p. Edited by Saravanamuthu Vigneswaran and Roger Ben Aim.

Descriptors: *Filtration, *Separation techniques, *Sludge treatment, *Ultrafiltration, *Vacuum filtration, *Wastewater treatment, *Water treatment, Centrifugation, Electrodialysis, Membrane processes, Reverse osmosis.

The various solid/liquid separation processes available for water and wastewater treatment are reviewed in 14 chapters arranged in a sequence that reflect their stage of development. The first two chapters give a brief review of the modifications which have occurred over the years in conventional deep bed filtration, along with theoretical approaches. Chapter 3 addresses direct filtration with its specific applications, while Chapter 4 describes the application of deep bed filtration to treatment of different types of wastewater. Chapters 5, 6, and 7 deal with microstraining, cartridge filtration, and precoat filtration, which were developed at a later stage and used for pretreatment and for specific treatment purposes. Chapters 8 through 11 discuss membrane processes, namely, reverse osmosis, electrodialysis, ultrafiltration, and microfiltration, with its specific applications in water and wastewater treatment. Chapters 12 through 14 discuss three different sludge dewatering methods commonly used, namely, vacuum filtration, pressure filtration, and centrifugation. Widely discussed sludge dewatering methods such as vacuum filtration and pressure filtration are treated in a general sense, while centrifugation is detailed in a more comprehensive manner. (See W90-08495 thru W90-08505) (Geiger-PTT) W90-08494

OVERVIEW OF DEEP BED FILTRATION: DIFFERENT TYPES AND MATHEMATICAL MODELS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering. For primary bibliographic entry see Field 5F. W90-08495

THEORETICAL APPROACH TO DEEP BED FILTRATION.
Gesamthochschule Duisburg (Germany, F.R.). Inst. of Water Technology. R. Gimbel. IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 17-56. 18 fig, 2 tab, 118 ref.

Descriptors: *Deep bed filtration, *Filtration, *Kinetics, *Mathematical models, *Model studies, *Wastewater treatment, *Water treatment, Particulate matter, Polyelectrolytes, Suspended solids, Theoretical analysis.

Deep bed filtration is widely used in water and wastewater treatment to remove suspended solids. To understand deep bed filtration, the macroscopic filter behavior and the microscopic filtration theory were studied. The macroscopic description deals with filtrate quality and pressure drop as a function of time on an extensive experimental basis. The microscopic filtration theory is strictly based on fundamental physicochemical mechanisms needing relatively little experimental information. To describe particle volume concentration, amount of deposit, and pressure as a function of filter bed depth and filter running time, the following points were considered: a mass balance for a differential filter bed element, a kinetic approach describing mass transfer from the flowing liquid to the stationary filter media, and an approach describing the increase of pressure drop with increasing deposit. Two different models exist to describe the flow through granular filter beds: internal flow models, whereby the elementary filter layer is represented by capillaries of various geometries, and external flow models, whereby the elementary filter layer is represented by spherical collectors in a flow field of distinct boundary conditions. Filter efficiency in the initial phase is discussed in terms of forces acting on particles in liquid deep bed filtration, and the elementary filter efficiency for Brownian and non-Brownian particles. A more realistic theoretical treatment of particle adhesion processes in deep bed filtration should take into account the general possibility for multiple contacts of a particle on the collector surface. To calculate the particle deposition in the dynamic filtration phase of a deep bed filter, the relative parameters for the initial phase should be taken into account as well as any change in the geometry of the filter bed by the deposit of turbid matter, surface forces and particle-to-particle interactions, and detachment of particles or particle agglomerates. (See also W90-08494) (Geiger-PTT) W90-08496

DIRECT FILTRATION.
Culligan Italiana S.p.A., Bologna (Italy). For primary bibliographic entry see Field 5F. W90-08497

APPLICATIONS OF DEEP BED FILTRATION IN WASTEWATER TREATMENT.
Tokyo Univ. (Japan). Dept. of Urban and Sanitary Engineering. K. Fujita. IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 77-100. 15 fig, 14 tab, 7 ref.

Descriptors: *Deep bed filtration, *Filtration, *Industrial wastewater, *Tertiary wastewater treatment, *Wastewater treatment, *Water reuse, Food-processing wastes, Leachates, Metal-finishing wastes, Pulp wastes, Recycling.

Filtration can be used in the treatment of wastewater from both non-industrial and industrial sources. Rapid filters are used in tertiary treatment of secondary effluent from sewage plants. Such filters are used following coagulation and sedimentation or after coagulation alone without the use of sedimentation. A significant number of large buildings in Japan have their own treatment facilities to reuse wastewater as flush water of toilets, air-conditioning water, and floor-cleaning water. A treatment process consisting of activated sludge followed by sand filtration can be used to recycle wastewater. In some districts in Japan and Korea, night soil is collected by vehicles from individual houses and treated by either aerobic or anaerobic digestion processes. Recently, many night soil treatment plants have incorporated tertiary treatment processes including biological denitrification, chemical coagulation, sedimentation, filtration, ozonation, and carbon adsorption. Filters may be used for refining discharged water from plants treating leachate from solid waste dump sites. During the steel-making process, filters are used for treating the wastewater from the continuous casting mill, hot strip mill, blooming roll mill, and electric plating shop of the cold roll mill. A filter applied to wastewater from a paper making plant using virgin pulp can allow pulp wastewater to be recycled for plant use. Recently ultrafiltration has been applied to treat bleaching wastewater from a pulp factory. Coagulation, sedimentation and filtration added to the activated sludge process treating beer brewery wastewater can considerably reduce COD, BOD and suspended solids. Coagulation, sedimentation, and filtration after the activated sludge process treating soft drink factory discharge produce a higher quality of treated water when required. Filtration and ultrafiltration are used in treating plating wastewater to recover nickel and reduce other metal wastes. In treating wastewater from research laboratories, each wastewater is classified into one of eight separate categories before pretreatment by filtration. (See also W90-08494) (Geiger-PTT) W90-08498

MICROSTRAINING.
Beaudrey (E.) and Cie, Paris (France). E. P. Jackson. IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 101-115. 10 fig.

Descriptors: *Filtration, *Microstraining, *Separation techniques, *Wastewater treatment, *Water treatment, Drinking water, Microfiltration, Water quality.

Microstraining uses very fine mesh fabrics to filter raw water for drinking water purposes, to treat sewage in a preliminary or tertiary stage, and to recover valuable fine particles or plankton from effluent waters. To measure the quality of the microstrained water, a method was developed for measuring the flow of water across a given area of fine mesh of the type used in an industrial microstrainer. The Boucher method (filterability index) consists of a constant flow system under a variable head. The Beaudrey method consists of a constant head and decreasing flow system. Reps or Dutch weave microstrainer fabric provides double straining obtained by apertures in different planes. The efficiency of the microstrainer is measured by testing samples of water before and after microstraining with a Colmatometer. The Beaudrey P.C. (B.P.C.) water quality measurement reductions depend on the mesh size; 35-micron mesh yields 60 to 70% B.P.C. reduction, and 22-micron mesh yields 80 to 90% B.P.C. reduction. Good microstraining performance is obtained for treating raw water for drinking water purposes when the source waters contain clear waters with moderate plankton content and no silt. For waters of all natures which contain suspended solids that do not easily settle, microstraining can be used as a preliminary treatment. Mesh of 22 microns is commonly used for microstraining as a polishing treatment for sewage water. For treatment of industrial water, microstraining is used as a fine screening method for protecting coolers, or as a preliminary treatment for special water preparation plants. Microstraining has been applied only in a few cases for primary sewage treatment. Attempts have been made to have pretreatment prior to microstraining to increase the removal efficiency of the microstrainer. Preozonation acts as a coagulant for the particles to be removed. Microstrainers are self-contained units that are normally installed in a concrete tank. Microstrainer sizing must be done very carefully and must allow for some extra capacity since water quality may vary beyond the expected B.P.C. values. The advantages of microstrainers are: compactness, very low head drop, high and constant efficiency, low energy requirements, no chemical requirements, very low spray water consumption, low maintenance, complete automation, no sludge treatment requirements, and less frequent washing of sand needed. (See also W90-08494) (Geiger-PTT) W90-08499

PRECOAT FILTRATION.
Manville de France, St.-Cloud. For primary bibliographic entry see Field 5F. W90-08500

REVERSE OSMOSIS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering. S. Vigneswaran. IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 139-158. 15 fig, 9 tab, 14 ref.

Descriptors: *Desalination, *Reverse osmosis, *Wastewater treatment, *Water treatment, Membrane processes, Model studies, Nitrates, Nitrogen removal, Potable water, Separation techniques, Solute transport, Theoretical analysis.

Reverse osmosis is a separation technique involving the passage of water molecules through a semipermeable membrane due to the application of pressure and involves no change either in phase or temperature. Cellulose acetate is the most universally used membrane material in the reverse osmosis process. Reverse osmosis membranes have been incorporated into tubular, spiral wound, or hollow fiber geometric devices. Fouling of reverse osmosis membranes can be attributed to precipitation of mineral salts, precipitation of metallic oxides, fouling by suspended solids, fouling by colloids, and proliferation of bacteria. Pretreatment by filtration, adjustment of parameters that affect the solubility of precipitates, coagulation of colloidal matter, and chemical treatment to avoid the formation of bacterial slime layers provide optimal performance of the reverse osmosis system. The flow resistance of the reverse osmosis membrane should be minimized while maintaining structural integrity. The transport model incorporating flux equations and performance variables will help in designing reverse osmosis membranes. Concentration polarization, the enrichment of the salt concentration in a boundary layer near the membrane surface with increased flow of water through the membrane and as salts are rejected by the membrane may also be modeled. When installing the reverse osmosis system, membrane selection, permeate flow rate, membrane life, and the cleaning frequency of membranes should be considered. Reverse osmosis is used in desalination for potable water treatment, production of pure water for industrial purposes, and treatment of municipal and industrial wastewater. (See also W90-08494) (Geiger-PTT)
W90-08502

ULTRAFILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 159-171. 7 fig, 8 tab, 14 ref.

Descriptors: *Filters, *Filtration, *Membrane processes, *Ultrafiltration, *Wastewater treatment, Industrial wastewater, Microfiltration, Pretreatment of water, Reverse osmosis, Tertiary wastewater treatment.

The ultrafiltration (UF) membrane allows the passage of water and low molecular weight solutes but retains macromolecules whose size is bigger than the pore size of the membrane. Typically, UF membranes have a thin (0.2 to 1 micron) surface skin supported by a porous substructure. Pore sizes can range from equivalent molecular weights as low as 1000 to as high as 100,000. There are three primary UF configurations: tubular, spiral-wound, and hollow fiber. To reduce fouling, high feed flow rate and lowest practicable hydraulic pressure difference across the membranes are used. The classical theory for UF depends on mass balance for the solutes in the laminar boundary layer formed at the membrane surface. The applications of UF, for the production of specifically treated water for industries, are numerous and include the fermentation of lactose, recovery of paints, treatment and recycle caustic extraction waste after bleaching in the paper and pulp industry, and removal of fiber in the textile industry. UF is also widely used in industrial wastewater treatment where recycling of raw materials, products, and by-products are of primary concern. It is also used in secondary and tertiary treatment of municipal wastewater. The economics of UF is dependent on the specific application. The advantages of UF for certain applications outweigh the disadvantages. The major differences of UF, microfiltration, and reverse osmosis are compared with respect to transfer mechanism, law governing the transfer, type of solution treated, permeability range of solvent, and pressure applied. (See also W90-08494) (Geiger-PTT)
W90-08503

MICROFILTRATION.
Enka A.G., Wuppertal (Germany, F.R.).
S. Ripperger.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 173-190. 14 fig, 2 tab, 22 ref.

Descriptors: *Filtration, *Membrane processes, *Microfiltration, *Wastewater treatment, *Water treatment, Design criteria, Economic aspects, Separation techniques.

Microfiltration (MF) is a pressure-driven membrane process for the separation of particles, microorganisms, large molecules, and emulsion droplets. The filter medium is a microporous membrane with a separation limit in the range of 0.02 to 10 microns. Microporous membranes are produced by phase inversion, molding and sintering of fine-grained powder, irradiation and etching processes, or stretching of sheets of partially crystalline polymers. In crossflow-filtration, the fluid to be filtered flows parallel to the surface of the filter medium. This parallel flow generates shearing forces and/or turbulences over the filter medium and limits the thickness of the filter cake. The transmembrane pressure influences the flux together with the back transport conditions and the thickness of the layer. Crossflow microfiltration (CMF) is the unit operation of a process which can include several post-treatment and pretreatment procedures. In general, a CMF plant consists of several membrane modules which are connected in a series and/or parallel. The periodic backflush with filtrate, the use of abrasives, pulsated flows, and electrophoresis are used to reduce the build-up of a layer on the membrane. The principal factors to be considered in an economical analysis of CMF are: the capital costs of the system depending on the flux, complexity of the system, required components other than membranes, replacement costs of the membrane, membrane lifetime, energy requirements for pumps, and labor costs (including time for membrane cleaning and membrane replacement). (See also W90-08494) (Geiger-PTT)
W90-08504

ELECTRODIALYSIS.
Toulouse-3 Univ. (France). Dept. of Chemical Engineering.
R. Audinos, and S. Vigneswaran.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 191-223. 14 fig, 7 tab, 29 ref.

Descriptors: *Desalination, *Electrodialysis, *Filtration, *Membrane processes, *Wastewater treatment, *Water treatment, Demineralization, Design criteria, Electrodes, Ion transport, Permeability, Pretreatment of water.

Electrodialysis (ED) is a physical method for extracting or concentrating ions in solutions by migration, under the influence of an electric field, through anion-selective and cation-selective membranes, without using the products of the electrode reactions. In an ED stack, more than 100 but less than 1000 unit cells are placed between two electrodes, resulting in hundreds of feed streams, dilute streams, and concentrate streams separated by spacer gaskets. Each spacer frame is provided with solution channels that connect the solution supply ducts with the solution compartment. The flow system of the stack may be cocurrent or counter-current. For external staging, two or more groups of cells, each with its own set of electrodes may be placed within the same clamping press. In the case of internal staging, all the groups of cells are put between two electrodes. Ion exchange membranes may be homogeneous or heterogeneous depending on their microstructure. Heterogeneous membranes are composed of more than one material, while homogeneous membranes are of uniform composition, even at the molecular scale. Microheterogeneous membranes are uniform from a macroscopic point of view. The most important principle involved in the ion exchange membrane process is the Donnan equilibrium relationship. In the design of an ED module, it is essential to relate the external electric potential applied at a given concentration distribution across the stack with the current density, the ionic flux, and osmotic flow.

These relationships are mathematically modeled, along with the critical current, transport and efficiency in a unit cell, and current efficiency of the stack. For process and equipment design, the material balance, demineralization factor, power requirement and instrumentation are considered. Sensors are used to measure conductivity, and process control may use an alarm or light to indicate excess salinity. ED requires filter pretreatment and in some cases, posttreatment to adjust pH. Whenever the membranes are suspected of producing a sieve effect, current reversal is practiced. ED finds wide applications in potable water, industrial wastewater, and wastewater treatment. (See also W90-08494) (Geiger-PTT)
W90-08505

VACUUM FILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5E.
W90-08506

PRESSURE FILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5E.
W90-08507

CENTRIFUGES FOR SLUDGE TREATMENT.
Stuttgart Univ. (Germany, F.R.). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5E.
W90-08508

VOLATILE ORGANIC CHEMICALS AND INTENTIONAL WATER REUSE.
Stanford Univ., CA. Dept. of Civil Engineering.
P. L. McCarty.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 127-138, 3 fig, 5 tab, 11 ref.

Descriptors: *Drinking water, *Volatile organic compounds, *Wastewater treatment, *Water pollution control, *Water quality control, *Water reuse, Activated carbon, Adsorption, Air stripping, Biological treatment, Monitoring, Wastewater management.

The quality of wastewaters to be used for intentional reuse can be improved through adequate control of industrial discharges and segregation to further reduce industrial and commercial contributions and stormwater runoff. Efficient biological treatment prior to advanced treatment also is effective in improving quality. There are a variety of advanced treatment processes available which collectively can further clean wastewaters to produce almost any quality of water desired. With VOCs, the most effective commonly used processes are air stripping and activated carbon sorption. In addition, with a highly competent management and technical team, with a significantly increased level of analytical monitoring over what is normally used in wastewater treatment, and by controlling flow rates through treatment systems and selecting water of the desired quality prior to reuse, a high degree of reliability can be built into the system. However, there are costs involved in each of these measures. The decision then concerns which measures are necessary in a given situation to ensure that the overall reuse system is sufficiently reliable and effective to provide the consumer now and in the future with a safe and wholesome drinking water supply. (See also W90-08509) (Lantz-PTT)
W90-08517

OPERATIONAL EXPERIENCES WITH THE INDUSTRIAL AND COMMUNAL WASTE WATER TREATMENT SYSTEM IN THE DISTRICT OF LINZ.
Stadtbetriebe Linz G.m.b.H. (Austria). Inst. fuer Wasseraufbereitung, Abwasserreinigung und - Forschung.
G. E. Reichel.

Water Science and Technology WSTED4, Vol. 22, No. 5, p 87-92, 1990. 2 fig, 1 tab.

Descriptors: *Biological treatment, *Combined treatment, *Danube River, *Wastewater treatment, Anaerobic digestion, Austria, Industrial wastewater, Linz, Municipal wastewater, Sludge digestion, Traun River, Wastewater facilities.

The city of Linz is situated on the Danube River between two hydroelectric power plants at Goldworth-Wilhering and Abwinden-Asten. Because of the construction of the hydroelectric plant in Abwinden-Asten, a central sewage treatment plant for 22 communities and the wastewaters of the chemical and steel industry, was constructed. A new concept which required the construction of a collector sewer along the Danube down below the hydroelectric plant at Abwinden-Asten and a fully biological treatment plant for all the wastewaters from industry and the surrounding communities, was utilized. For the wastewater from the northern part of the city, it was decided to construct a duct under the Danube so that the wastewater could be transferred from the left bank to the right bank of the Danube. A tunnel with a length of 373 m at a depth of 25 m was constructed. On the right bank where the different harbors for the city are situated and under the river Traun, further tunnels with a total length of 2.1 km and a depth of 30 m below the water level of the Danube, were constructed. The three collectors were then connected to a main collector. Approximately 13 km from the center of the city the biological sewage treatment plant was erected so that the treated wastewater could be fed into the Danube below the hydroelectric plant at Abwinden-Asten. According to this scheme, the following wastewaters are being collected and treated in the newly constructed treatment plant: (1) the communal wastewater from 22 communities, which amounts to about 565,000 population equivalents (PE); (2) the industrial wastewater from the chemical industry (100,000 PE); (3) the wastewater from the steel industry (45,000 PE); (4) wastewaters from the apple juice producing industry (25,000 PE); (5) wastewater from the paper producing industry (10,000 PE). In 1991, the wastewaters from a second pulp factory (100,000 PE) will also be led into the sewage treatment plant. Purification efficiency in terms of biochemical oxygen demand for 5 hours is 93% and 83% for chemical oxygen demand. The anaerobic digested sludge is deposited into lagoons. (Agostine-PTT)
W90-08616

DEVELOPMENT OF WATER POLLUTION CONTROL IN AUSTRIA: AN EXAMPLE OF A RIPARIAN STATE IN THE DRAINAGE AREA OF THE RIVER DANUBE.
Technische Univ., Vienna (Austria). Inst. fuer Wasserguete und Landschaftswasserbau.
For primary bibliographic entry see Field 5G.
W90-08634

VIENNA SEWERAGE SYSTEM.
Vienna Municipal Dept., Austria.
P. Bortenschlager.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 235-240, 1990. 4 fig.

Descriptors: *Sewer systems, *Vienna, *Wastewater facilities, *Water quality, Austria, Danube River, Groundwater quality, Industrial wastewater, Municipal wastewater, Relief sewers.

For many decades the wastewater of Vienna had been discharged to the nearest body of water, i.e. the Wien River, Danube Canal, and Danube River. In the period 1969-1980, numerous intercepting sewers and a central treatment plant were built. The facilities guaranteed that all effluent produced in Vienna was brought to the central treatment plant for purification. Since 1986 a program has been in effect to expand the existing sewage system and improve obsolete sewers, the aim being to preserve groundwater quality. Providing also for the construction of relief interceptors along the Danube Canal and the Wien River as well as the enlargement of the central treatment plant, the program was designed not only to preserve but

also to improve water quality in the Danube Canal and the Danube itself. The city has appropriated AS 12,000 million for this project, which is to be completed by the year 2000. (Agostine-PTT)
W90-08636

IMPACT OF MUNICIPAL WASTEWATER ON THE QUALITY OF THE RIVER SAVA.
Zagreb Univ. (Yugoslavia). Faculty of Civil Engineering.
For primary bibliographic entry see Field 5C.
W90-08642

5E. Ultimate Disposal Of Wastes

USER'S GUIDE FOR MODELS OF DREDGED MATERIAL DISPOSAL IN OPEN WATER.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
B. H. Johnson.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-90-5, February 1990. Final Report. 101p, 7 fig, 15 ref, 6 append.

Descriptors: *Dredging wastes, *Fate of pollutants, *Model studies, *Ocean dumping, *Path of pollutants, *Waste disposal, Handbooks, Mathematical models, Suspended sediments.

Mathematical models that account for the physical processes determining the short-term fate of dredged material disposed at open-water sites provide estimates of suspended sediment concentrations in the receiving water and the initial deposition pattern and thickness of material on the bottom. Two such models were developed under the US Army Corps of Engineers Dredged Material Research Program to handle both instantaneous dumps and continuous discharges. A third model using features of the two earlier models has been constructed to handle a semicontinuous disposal operation from a hopper dredge. These models are known as DIFID (Disposal From an Instantaneous Dump), DIFCD (Disposal From a Continuous Discharge), and DIFHD (Disposal From a Hopper Dredge). DIFID should be applied when the disposal operation is essentially instantaneous, whereas DIFCD is applicable to continuous disposal operations, e.g., pipeline disposal. DIFHD has been developed for application to dredged material disposal from a stationary hopper dredge in which two or more bins discharge material simultaneously. Example applications of the models at a constant-depth site presented in Appendices A, B, and C serve to illustrate that very little input data are required for such applications. (Lantz-PTT)
W90-07518

MEASUREMENT OF HYDROLOGIC PARAMETERS OF CONFINED DREDGED MATERIAL AT WILMINGTON HARBOR, DELAWARE, CONTAINMENT AREA.
Delaware Univ., Newark. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W90-07519

METHODOLOGY FOR ANALYSIS OF SUBAQUEOUS SEDIMENT MOUNDS.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
M. E. Poindexter-Rollings.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-90-2, February 1990. Final Report. 119p, 48 fig, 1 tab, 83 ref, append.

Descriptors: *Dredging wastes, *Ocean dumping, *Waste disposal, Case studies, Mathematical studies, Mounds, Physical properties, Sediments.

Dredging of contaminated sediments and subsequent disposal and capping in legally designated disposal sites is an internationally accepted disposal alternative when adherence to strict disposal practices is maintained. As more highly contaminated sediments in the heavily industrialized harbors of the world must be dredged to maintain navigation

and economic viability, pressure to use subaqueous dredged material disposal sites will increase. A methodology of analysis was developed to investigate the behavior of the created subaqueous sediment mounds. Emphasis was placed upon the physical aspects of mound behavior, although the methodology also includes chemical and biological aspects. The physical aspects of the methodology were applied to four field sites at which dredged material mounds have been created: Duwamish Waterway site; Long Island Sound sites; Stamford-New Haven North mound; and Stamford-New Haven South mound. The procedure successfully predicted the physical behavior of the constructed dredged material mounds. This method of analysis provides a useful tool for evaluation of subaqueous disposal sites and the dredged material mounds created within these sites; it is equally applicable to analysis of contaminated and uncontaminated dredged material mounds. (Author's abstract)
W90-07520

METHODS OF DETERMINING THE LONG-TERM FATE OF DREDGED MATERIAL FOR AQUATIC DISPOSAL SITES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5B.
W90-07521

LONG-TERM MONITORING OF ELEVEN CORPS OF ENGINEERS HABITAT DEVELOPMENT FIELD SITES BUILT OF DREDGED MATERIAL, 1974-1987.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
M. C. Landin, J. W. Webb, and P. L. Knutson.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-89-1, December 1989. Final Report. 221p, 30 fig, 42 tab, 61 ref, append.

Descriptors: *Dredging wastes, *Habitat restoration, *Habitats, *Waste disposal, Environmental policy, Management planning, Monitors, Policy making.

Eleven habitat development field sites built by the US Army Corps of Engineers (CE) on dredged material were monitored from 1974-1987 in response to questions regarding their ecological contribution and longevity in comparison to natural habitats. Seven of these sites (Nott Island, CT; Windmill Point, VA; Buttermilk Sound, GA; Apalachicola Bay, FL; Bolivar Peninsula, TX; Salt Pond No. 3, CA; and Miller Sands Island, OR) were built during the CE Dredged Material Research Program. Four sites (Gaillard Island, AL; Lake of the Woods, MN; Pointe Mouillee, MI; and Southwest Pass, LA) were built by CE Districts and added to the long-term monitoring effort. Each of the 11 sites differed according to the type of habitat developed, location, dredged material substrate, structural development, water and energy regime, and, land-use potential, regional habitat needs, salinity, or other pertinent features that were representative of those encountered most often by field personnel in CE District offices where dredging occurs. Ten major recommendations for habitat development and restoration using dredged material and other construction soils include: careful planning where habitat development will be included; examine nearby sites in the project vicinity to determine habitat needs and the likelihood of construction success; take into account site variables; develop a set of criteria and objectives where habitat development and natural resource goals are included during project early planning stages; remain flexible in these criteria and objectives, because a site may develop over time into a similar but equal habitat rather than the hoped-for habitat because of unforeseen factors; develop a contingency management plan in case alternate habitats should evolve over time on the dredged material; provide careful instruction to dredging inspectors whose responsibilities include seeing that elevational land dredge pipe movement specifications are exactly fulfilled; provide funding as well as authorization for habitat development activities; and develop long-range management

plans for dredging and placement that incorporates natural resource beneficial uses. (Lantz-PTT)
W90-07566

LANDFILL CO-DISPOSAL OF PHENOL-BEARING WASTEWATERS: ORGANIC LOAD CONSIDERATION.
University of Strathclyde, Glasgow (Scotland). Dept. of Bioscience and Biotechnology.
I. A. Watson-Craik, and E. Senior.
Journal of Chemical Technology and Biotechnology JCTBDC, Vol. 47, No. 3, p 219-233, 1990. 6 fig, 31 ref.

Descriptors: *Hazardous waste disposal, *Landfills, *Methane, *Organic loading, *Organic wastes, *Phenols, *Wastewater analysis, *Wastewater disposal, Analytical methods, Biodegradation, Methanogenesis, Model studies.

A multi-stage model, operated with single elution, was used to investigate the effects of organic loadings on the attenuation of a model phenolic wastewater in domestic refuse. Although 100 percent dissimilation of influent phenol (2-5 mmol per cubic decimeter) was recorded at a dilution rate of 0.007 per hour, partial inhibition of both phenol degradation and species competing with methanogens for a common electron donor(s) was apparent at concentrations greater than or equal to 4 mmol per cubic decimeter. On extended perfusion with 8 mmol phenol per cubic decimeter, the progressive inhibition of phenol dissimilation was not obviated by nutrient supplementation. Simultaneous degradation of the catabolic intermediate, hexanoic acid, and elevated methane release rates suggested that the transformation of phenol to hexanoate was rate limiting. (Author's abstract)
W90-07572

HYDRAULIC CHARACTERISTICS OF MUNICIPAL REFUSE.
Converse Consultants East, Caldwell, NJ.
I. S. Oweis, D. A. Smith, R. B. Ellwood, and D. S. Greene.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 4, p 539-553, April 1990. 13 fig, 3 tab, 14 ref.

Descriptors: *Hydraulic conductivity, *Hydraulic properties, *Leachates, *Municipal wastes, *Path of pollutants, *Waste disposal, Landfills, Pumping tests, Solid wastes, Test wells, Water pollution control.

A review is made of the hydraulic conductivity and other hydraulic parameters of municipal waste. The hydraulic conductivity can be assessed indirectly from measured field parameters and water balance. A test well penetrating about 100 ft of refuse was installed and pumped for about one day at 20 gpm and 2 1/2 days at 12 gpm. Drawdowns were measured at three observation wells and the pumped well. The hydrogeologic parameters were computed using conventional hydrogeologic analysis. Based on the results of a pumping test of leachate from a municipal landfill, hydraulic conductivity of municipal refuse is about .001 cm/s. Pumping of leachate from a municipal landfill is feasible for control of leachate release to ground water. Leachate pumping may offer an attractive cost-effective alternative for leachate management when compared to cutoff walls, toe drains, etc. While municipal refuse has a substantially different composition than typical soils, the laws governing water flow in soils appear to be applicable to refuse on a macroscale basis. (Chonka-PTT)30 Mar 90
W90-07594

MONTE CARLO ANALYSIS AND BAYESIAN DECISION THEORY FOR ASSESSING THE EFFECTS OF WASTE SITES ON GROUND-WATER, I: THEORY.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5C.
W90-07614

MONTE CARLO ANALYSIS AND BAYESIAN DECISION THEORY FOR ASSESSING THE EFFECTS OF WASTE SITES ON GROUND-WATER, II: APPLICATIONS.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 2F.
W90-07615

LOW-LEVEL ALKALINE SOLUBILIZATION FOR ENHANCED ANAEROBIC DIGESTION.
Southern Illinois Univ. at Carbondale. Dept. of Civil Engineering and Mechanics.
For primary bibliographic entry see Field 5D.
W90-07630

TREATMENT AND DISCHARGE TO A POTW: THE STRINGFELLOW EXPERIENCE.
Environmental Protection Agency, San Francisco, CA. Region IX.
For primary bibliographic entry see Field 5G.
W90-07633

PLANT UPTAKE OF SLUDGE-BORNE PCBS.
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.
For primary bibliographic entry see Field 5B.
W90-07704

CONTROL OF ARBORESCENT VEGETATION BELOW POWER LINES WITH WASTEWATER SLUDGE.
Quebec Ministere de l'Energie et des Ressources, Sainte-Foy. Service de la Recherche Appliquee.
Y. Grenier, and D. Couillard.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 141-146, 1990. 4 fig, 7 tab, 19 ref. Natural Sciences and Engineering Research Council of Canada Grant NSERC OGP0003711.

Descriptors: *Plant growth, *Sludge disposal, *Sludge utilization, *Trees, *Vegetation regrowth, Electric power, Fertilization, Right-of-way, Shrubs.

A 1-year field study was conducted to determine whether fertilization with wastewater sludge could favor growth of herbaceous and shrub species to inhibit or eliminate the growth of tree species under power lines. Results show that a significant proportion of the trees died: mortality ranged from 35 to 100% on plots that received 160 Mg/ha of sludge, and ranged from 1 to 31% on control plots. The surviving trees showed accelerated growth. Means of height increments ranged from 17 to 86 cm on plots receiving 80 Mg/ha of sludge, and ranged from 5 to 31 cm on control plots. Sludge applications also decreased regeneration success for trees in the current year, with a minimum of 0.8 and a maximum of 7.0 new seedlings per 12.5 sq m on treated plots, as compared to 14.0 new seedlings on control plots. With the short duration of this preliminary study, it is concluded that the herb and shrub strata did not have sufficient time to fully develop in a single growing season and that the hypothesis remains to be verified. (Author's abstract)
W90-07708

GROWTH AND ELEMENTAL CONTENT OF SLASH PINE 16 YEARS AFTER TREATMENT WITH GARBAGE COMPOSTED WITH SEWAGE SLUDGE.
Florida Univ., Gainesville. Dept. of Forestry.
E. J. Jokela, W. H. Smith, and S. R. Colbert.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 146-150, 1990. 1 fig, 5 tab, 26 ref.

Descriptors: *Bioaccumulation, *Compost, *Forests, *Pine trees, *Sludge disposal, *Sludge utilization, *Solid waste disposal, Nutrient cycling, Path of pollutants, Plant growth, Plant tissues, Recycling, Tissue analysis, Waste recovery.

Landspreading of organic wastes remains an environmentally acceptable option for recycling nutrients. Tree growth and elemental tissue concentrations in a slash pine (Pinus eliottii Engelm.) planta-

tion treated 16 years previously with four rates (0, 112, 224, and 448 Mg/ha) of municipal garbage composted with sewage sludge were assessed. Tree growth was significantly greater where garbage compost was applied. Stem wood biomass increased from 55.7 to 94.7 Mg/ha at the heaviest garbage application rate, a 1.7-fold increase over the control. Annual tree basal area increment responses were also largest and most long-lasting (up to 9 years) for the 448 Mg/ha rate. Significant, but modest treatment-associated increases in concentrations of nitrogen, phosphorus, boron, iron, aluminum, and zinc in pine tissues (foliage, stem wood), and phosphorus and calcium in Rubus spp., a dominant understory plant, were found after 16 years. Analysis of pine xylem tissue corresponding to the juvenile and post-crown closure growth phases revealed significantly higher concentrations of potassium, calcium, magnesium, copper, aluminum and zinc in the latter period. Results suggest that landspreading and recycling degradable organic wastes in forests can increase tree and understory growth without long-term deleterious ecosystem effects. The applicability of these results to a typical community in a forested landscape is illustrated. Nationally, Florida ranks near the top in total area annually reforested and in solid waste generation per capita. Coupling these two activities, in accordance with results from this study, could substantially benefit municipal solid waste disposal through forest recycling, while increasing tree and understory growth without long-term deleterious effects to the ecosystem. (Author's abstract)
W90-07709

LEACHATE TREATMENT: DESIGN RECOMMENDATION FOR SMALL BUT EXTREMELY FLUCTUATING, HIGHLY POLLUTED QUANTITIES OF WATER.
Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.
For primary bibliographic entry see Field 5D.
W90-07811

EVALUATION OF LAND APPLICATION USING SECONDARY EFFLUENT IN A FOREST SLOPE: ESTIMATION OF DRAINED WATER QUALITY AND DISCUSSION OF THE EFFECTS UPON SOIL OR PLANTS AND BEHAVIOR OF BACTERIA.
Kagawa Univ., Takamatsu (Japan).
T. I. Itoyama, H. Yokose, S. Yoshida, and M. Kuwahara.
Water Research WATRAG, Vol. 24, No. 3, p 275-288, March 1990. 3 fig, 14 tab, 16 ref. English summary.

Descriptors: *Forests, *Land disposal, *Path of pollutants, *Wastewater disposal, *Wastewater utilization, Bioaccumulation, Calcium, Coliforms, Costs, Nitrates, Silicon dioxide, Soil contamination.

The secondary effluent of domestic wastewater was sprinkled on a slope in forest land in order to evaluate water reuse and to examine changes in the chemical properties of the soil and plants. Hydrologic data was obtained from the test area. Except for calcium, silicon dioxide, and nitrate, the concentration of most ions and compounds decreased, but some ions accumulated in the soil. Of these, chloride and manganese ions were absorbed by a few plant species. Wastewater sprinkling caused favorable effects on tree growth and changes in weed species composition. There was a marked degree of coliform bacteria removal during passage of the effluent, probably due to filtration and/or absorption effects of the soil. Few unfavorable effects on plant growth and soil were found. The cost of this procedure compared favorably with that of advanced wastewater treatment. Daily application of 30,000 to 35,000 liters of wastewater per 1100 square meters over a 2-hour period is recommended. (Shidler-PTT)
W90-07908

Group 5E—Ultimate Disposal Of Wastes

REVIEW OF TREATMENT PROCESS OP-
TIONS TO MEET THE EC SLUDGE DIREC-
TIVE.
Water Research Centre, Swindon (England).
Swindon Engineering Centre.
For primary bibliographic entry see Field 5D.
W90-07927

REVIEW OF POLLUTION FROM WASTE IN-
CINERATION.
Leeds Univ. (England). Dept. of Fuel and Energy.
P. T. Williams.
Journal of the Institution of Water and Environ-
mental Management JIWMEZ, Vol. 4, No. 1, p 26-
34, February 1990. 2 fig, 10 tab, 43 ref.

Descriptors: *Air pollution sources, *Incineration,
*Solid waste disposal, *Waste disposal, *Water
pollution sources, Combustion, Dioxins, Furans,
Heavy metals, Polycyclic aromatic compounds,
Reviews.

The incineration of waste is increasingly being
considered as an alternative to landfill as a means
of disposal. Incineration produces a non-putresci-
ble and sterile ash. In addition, incineration has the
advantage of the option of waste-heat recovery to
reduce costs, but there is some concern that pollu-
tion arising from waste incineration may be unac-
ceptable. The incineration of domestic, commercial
or industrial waste may produce pollutant emis-
sions to the atmosphere, contaminated wastewater,
and contaminated ash. The emissions are discussed
in detail in terms of odor, dust and litter, particu-
late metals and salts, and chlorine, fluorine, sulfur,
and nitrogen compounds. The products of incom-
plete combustion of waste are reviewed with par-
ticular emphasis on polycyclic aromatic com-
pounds, dioxins, and furans. (Brunone-PTT)
W90-07930

ON-SITE TREATMENT OF LEACHATES
FROM LANDFILLED WASTES.
Aspinwall and Co., Shrewsbury (England).
For primary bibliographic entry see Field 5D.
W90-07936

CITY DEALS WITH SLUDGE COMPOSTING
DILEMMA.
Eder Associates, Locust Valley, NY.
T. Swenson.
Public Works PUWOAH, Vol. 121, No. 3, p 60-61,
March 1990. 2 fig.

Descriptors: *Composting, *Landfill covers, *Mu-
nicipal wastes, *Sludge disposal, *Sludge utiliza-
tion, *Waste disposal, *Waste management, Com-
post, Leachates, Recycling, Sludge drying, Sludge
lagoons, Sludge treatment, Water pollution pre-
vention.

Waste disposal is an old problem in need of some
new solutions. With municipal landfills at or near
capacity in many parts of the country, and public
awareness of this problem on the upswing, the
search for efficient, cost-effective, environmental-
ly-sound disposal techniques is gaining momentum.
Recently the New York State Energy Research
and Development Authority (NYSERDA) agreed
to fund 50% of the cost of a sludge composting
experiment undertaken by the city of Plattsburgh,
New York. Plattsburgh needed a plan to close four
lagoons that were once used to dispose of dewa-
tered sludge from the city's wastewater treatment
plant. Instead of covering the lagoons with import-
ed soil, the city decided to investigate the feasibili-
ty of composting a portion of the sludge in the
lagoons and using the composted material as a
substitute cover material. The city developed a
plan that composted the sludge with other solid
wastes, such as leaves, newspaper, and waste prod-
ucts from local paper mills. By redirecting waste
materials from landfills and incinerators to the
compost pile, this approach would help promote
the goal of the New York State Solid Waste Man-
agement Plan to put waste products to beneficial
reuse. At the same time, using sludge compost for
the cover material would reduce the column of
sludge in the lagoons, and would make it easier to
close the lagoons in an environmentally sound

manner. Sludge will be removed from the lagoons,
blended with selected amendments and piled into
windrows with compost turning equipment. The
site will be cleared and graded to divert surface
runoff around the composting area, and any leach-
ate generated by the composting operation will
drain to a collection system already in place at the
site. As recognized by NYSERDA, this study
should benefit many other municipalities seeking
ways to improve their waste management systems.
Facing a waste disposal crisis, it will be difficult to
ignore a method that reduces sludge while provid-
ing lower cost landfill cover. (Brunone-PTT)
W90-07947

REAL-TIME CONTROL SYSTEM FOR CSO
REDUCTION.
Municipality of Metropolitan Seattle, WA.
Z. Vitasovic, R. Swarner, and E. Speer.
Water Environment & Technology, Vol. 2, No. 3,
p 58-65, March 1990. 3 fig, 1 tab.

Descriptors: *Combined sewer overflows, *Con-
trol systems, *Storm runoff, *Wastewater disposal,
*Water pollution control, Combined sewers, Com-
puters, Drainage systems, Industrial development,
Mathematical models, Population growth, Real-
time control system, Seattle, Simulation analysis,
Storms, Wastewater collection.

Many cities around the world are faced with com-
bined sewer overflow (CSO) problems. These
overflows occur in combined sewer systems during
storms when sewer capacity is exceeded and the
mixture of stormwater and wastewater is released
to receiving waters untreated. The pollution load
that CSOs introduce to the environment has been
increasing because of stronger loads on the drain-
age system from population growth and industrial
development. The problem is sometimes alleviated
by constructing storage facilities or separated
sewers, but, in many cases, the cost of such
projects is prohibitive. The Municipality of Metro-
politan Seattle (Metro), Washington, has been
using a computer to control a combined sewer
collection system since 1973. Metro is in the proc-
ess of upgrading both the hardware and the soft-
ware in its control system. Thus, mathematical
models and the initial design for an advanced auto-
matic control system for real-time control of pump
stations and regulator stations have been devel-
oped. The control system helps reduce the overall
volume of the combined wastewater released from
the conveyance system during storms by using the
available in-line storage. Using models for hydrau-
lic flow, routing and runoff and transport models,
Metro is able to begin implementation of a real-
time CSO control system. The model can simulate
surcharged conditions, which occur frequently in
storms, and can simulate the dynamic operation of
the sewer network, but it cannot handle rapidly
varied flow. During 1989 the models were used to
evaluate control strategies, and in the fall of 1990
the new control programs will be started up.
(Brunone-PTT)
W90-07954

CHICAGO'S ANSWER TO OVERFLOW:
TUNNEL VISION.
Metropolitan Water Reclamation District of
Greater Chicago, IL. Public Information Office.
C. Cook.
Water Environment & Technology, Vol. 2, No. 3,
p 66-67, March 1990. 2 fig, 1 tab.

Descriptors: *Combined sewer overflows, *Flood
control, *Storm-overflow sewers, *Tunnels,
*Water pollution control, Chicago, Human popula-
tion, Pipelines.

A project of the Metropolitan Water Reclamation
District of Greater Chicago, the Tunnel and Reser-
voir Project (TARP) is one of the largest public
works projects ever undertaken. Its four systems
(the Des Plaines, Upper Des Plaines, Mainstream,
and Calumet) serve 375 square miles of combined
sewer area within the District. The county has a
residential population of 5.2 million and an indus-
trial population that is equivalent to another 4.5
million persons. The enormous engineering project
was designed to prevent backflows into Lake

Michigan, the source of the area's drinking water,
to eliminate waterway pollution caused by com-
bined sewer overflows (CSOs), and to provide an
outlet for flood waters. All of these objectives had
to be met while complying with federal and state
environmental laws and keeping an eye on the
taxpayers' dollars. TARP consists of two phases.
Phase I is designed to eliminate 85% CSO pollu-
tion and Phase II provides for flood control. The
directions to effective pollution abatement and
flood control have been mapped out by an aggres-
sive and innovative elected board of commission-
ers. The Middle and South Legs of the Des Plaines
system are currently under construction, with an
estimated completion date of May 1993. (Brunone-
PTT)
W90-07955

IMPACT MANAGEMENT PRIORITIES AT
WASTE FACILITIES: DIFFERENCES BE-
TWEEN HOST COMMUNITY RESIDENTS'
AND TECHNICAL DECISION MAKERS'
VALUES.
Alberta Univ., Edmonton. Dept. of Civil Engi-
neering.
C. Zeiss.
Journal of Environmental Systems JEVSBH, Vol.
19, No. 1, p 1-23, 1989/90. 6 fig, 9 tab, 13 ref.

Descriptors: *Decision making, *Management
planning, *Public opinion, *Social impact, *Waste
disposal, *Waste disposal facilities, Cost analysis,
Public relations, Site selection, Waste management.

Host-community residents often oppose waste dis-
posal facilities despite well intentioned efforts by
technical decision-makers to address impacts. Con-
flicts over facility siting may stem from differences
in impact management priorities between residents
and technical decision-makers. Underlying these
differences may be disparities in valuing facility
impacts, as indicated by recent studies. This study
tests for value differences by presenting three sets
of impact management measures to host-communi-
ty residents and technical decision-makers. Gener-
ally, residents more strongly than engineers favor a
preventive approach despite higher costs. Prefer-
ences for specific measures are blurred, but resi-
dents follow a preventive rationale, while technical
decision-makers consider cost effectiveness. As a
result, engineers and planners must be aware of
their own empirical tendency to undervalue im-
pacts (losses) and overvalue benefits (gains) from
waste facilities. Hence, technical decision-makers
must take into account the higher sensitivity and
resistance to changes among personally affected
persons in selecting impact management measures
for undesirable facilities. (Author's abstract)
W90-08007

LANDFILL REUSE STRATEGIES.
New York State Energy Research and Develop-
ment Authority, Albany.
J. Morelli.
Biocycle BCYCDK, Vol. 3, No. 3, p 40-43, 62,
March 1990.

Descriptors: *Landfills, *Leachates, *Municipal
wastes, *Solid wastes, *Waste disposal, *Water
pollution prevention, Biodegradation, Carbon di-
oxide, Design criteria, Methane, Waste treatment.

The landfill is a primary municipal solid waste
(MSW) management option that is here to stay. It
can be a manageable and potentially beneficial
treatment system that can be optimized. Optimiz-
ing the design and operation of the landfill as a
biochemical treatment system and as the central
component of any integrated MSW system is con-
sidered here. Approximately 78% by weight of the
MSW stream is organic material, of which less
than 10% is not biodegradable. Paper, yard wastes,
and food waste predominate in the organic compo-
nent. The conventional landfill was not designed to
optimize biodegradation and methane production.
The landfill is a biochemical reactor that, under
appropriate conditions of moisture, nutrients, tem-
perature and other factors, is capable of producing
methane and carbon dioxide gases and leachate.
Leachate recirculation is an accepted method of

accelerating decomposition processes in a MSW landfill. Ample evidence exists indicating that at a moisture content of about 60%, maximum biodegradation rates are reached. Shredding of the solid waste before landfilling in a treatment cell increases the surface area of the waste and provides more opportunity for solubilization and microbial activity. For a landfill to be reusable, there must be sufficient treatment cells that are small enough so that the operator can fill them sequentially and return to the first cell after a sufficient period of time has passed for the cell to stabilize. Both conventional and reusable landfills require the same amount of space for the first 20 yr. After this time, the reusable landfill is more attractive, although for large landfills this benefit is offset by increasing cell height. Reusable landfills look better for municipalities in the 30,000 range. (Rochester-PTT)
W90-08036

ODOR SOURCE EVALUATION.
Greeley and Hansen, Camp Springs, MD.
C. Wilber, and C. Murray.
Biocycle BCYCDK, Vol. 3, No. 3, p 68-72, March 1990.

Descriptors: *Composting, *Odors, *Sludge disposal, *Sludge treatment, Biological oxygen demand, Moisture, Nitrification, Temperature, Waste treatment.

Research conducted for the Washington Suburban Sanitary Commission focused on the conditions affecting the generation of odor causing compounds during composting. Parameters considered included: pH, temperature, air rate, oxygen level, and sludge source and conditioning. The odor compound groups important to composting are fatty acids, amines, aromatics, inorganic sulfur, organic sulfur, and terpenes. All are malodorous. Odor production by these compounds was studied during composting of primary and secondary sludges, sludges from nitrification processes, anaerobically digested and raw sludges, and sludges treated with lime and other conditioning materials such as ferric sulfate used for phosphorus removal. The oxygen demand of secondary, primary, nitrified, and anaerobically digested sludges was 3.6, 1.6, 0.9, and 0.9 mg of oxygen/gram of sludge/hour, respectively. A direct correlation between oxygen demand and odor production was found. Composting secondary sludge produced the highest level of odor, followed by blends of primary and secondary sludge, primary sludge, and anaerobically digested and nitrified sludge. Less odor production occurred at higher temperatures, but less moisture loss and degradation took place. Means of reducing odor production suggested by the present work include: (1) minimize moisture into the process; (2) obtain a good mix; (3) consider alternative sludges if possible, and (4) operate at the highest temperature possible for moisture and stability control. (Rochester-PTT)
W90-08037

MANAGING INDUSTRIAL HAZARDOUS WASTE: A PRACTICAL HANDBOOK.
For primary bibliographic entry see Field 5G.
W90-08136

HANDBOOK: ESTIMATING SLUDGE MANAGEMENT COSTS.
Environmental Protection Agency, Washington, DC. Office of Research and Development.
For primary bibliographic entry see Field 5D.
W90-08176

WASTEWATER DISPOSAL.
Post, Buckley, Schuh and Jernigan, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5D.
W90-08182

STORMWATER MANAGEMENT.
Browne (F.X.) Associates, Inc., Lansdale, PA.
For primary bibliographic entry see Field 5D.
W90-08183

APPROXIMATE CALCULATION OF ADVECTIVE GAS-PHASE TRANSPORT OF 14C AT YUCCA MOUNTAIN, NEVADA.
Lawrence Livermore National Lab., CA. Earth Sciences Dept.
For primary bibliographic entry see Field 2G.
W90-08203

ESTIMATING UNCERTAINTY OF STORMWATER RUNOFF COMPUTATIONS.
Texas Univ. at Dallas, Richardson. Inst. for Environmental Sciences.
For primary bibliographic entry see Field 4C.
W90-08274

VACUUM FILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 225-236. 3 fig, 3 tab, 12 ref.

Descriptors: *Dewatering, *Filtration, *Separation techniques, *Sludge drying, *Vacuum filtration, *Wastewater treatment, *Water treatment, Design criteria, Filter media, Industrial wastes, Sludge conditioning.

A vacuum filter used for dewatering sludge during wastewater treatment, consists of a cylindrical rotating drum covered with a filter medium, a portion of the circumference being submerged in the sludge to be filtered. Water is drawn through the filter medium by an applied internal vacuum. Two typical vacuum filters are the vacuum leaf filter and vacuum nutsche. Vacuum filters can be designed based on experience, the filter leaf test or specific resistance of cake. The selection of vacuum level, degree of drum submergence, drum speed, and medium type are very important to obtain optimum performance. Optimum performance of vacuum filters also depends on the type of sludge and its solids concentration, conditioning and pretreatment, and filter operating conditions. Vacuum filtration is commonly used in dewatering of various kinds of sludges, including water treatment plant sludges, domestic wastewater sludges, and industrial waste sludge. Vacuum filtration has several advantages, namely, the proportion of solids in sludges is increased, resulting in the reduction of sludge volume, reduction in incineration costs, less odor problems, and greater ease of handling. Among the disadvantages of vacuum filtration are its high initial investment, requirement of skillful operators, need for chemical conditioning, clogging of the filter, and faster deterioration of the filter. (See also W90-08494) (Geiger-PTT)
W90-08506

PRESSURE FILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 237-247. 5 fig, 2 tab, 7 ref.

Descriptors: *Dewatering, *Filters, *Filtration, *Pressure filtration, *Sludge drying, *Wastewater treatment, Design criteria, Separation techniques, Sludge conditioning.

Pressure filters are used for solid-liquid separation of sludge by the application of pressure on the solid-liquid mixture to squeeze out the liquid through a filter medium. The basic equations for pressure filtration theory are derived from Darcy's law. Pressure filters are classified into two groups, namely batch and continuous pressure filters, based on their mode of operation. Batch filters are grouped into three different types: filter presses; leaf, plate, and candle (tubular) filters; or variable-volume filters (membrane filters). The following variables are to be chosen to obtain optimum performance of a pressure filter: pressure drop, slurry temperature, initial mass flux, filtration time, and downtime. Pressure filters are used in the chemical, ceramics, coal waste processing, and dye stuffs industries, as well as in wastewater treatment, fats

and food processing, kaolin, chalk, sugar, and paper industries. (See also W90-08494) (Geiger-PTT)
W90-08507

CENTRIFUGES FOR SLUDGE TREATMENT.
Stuttgart Univ. (Germany, F.R.). Dept. of Chemical Engineering.
C. Alt.
IN: Water, Wastewater and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 249-273. 11 fig, 3 tab, 14 ref.

Descriptors: *Centrifugation, *Dewatering, *Separation techniques, *Sludge thickening, *Sludge treatment, Filtration, Sedimentation, Sludge conditioning, Sludge drying, Wastewater treatment.

Centrifugation may be one of the earliest methods used by man to separate a multiphase mixture. Centrifuges presently accomplish diverse tasks in wastewater treatment. Centrifuges are used in two stages of sludge separation: sludge dewatering and sludge thickening. Sedimentation centrifuges have proved sufficiently effective, reliable, and economical in wastewater sludge dewatering and thickening practice. Centrifugal sedimentation is explained by Stokes' law (similar to gravitational settling). The throughput in a sedimentation centrifuge is explained by the unit area equivalent. Sedimentation centrifuges consist of a solid bowl into which the sludge enters at one end, in most instances through a feed funnel, or through appropriate equipment, while the liquid overflows over the settled solids and flows out through effluent ports or weirs at the opposite end of the bowl. In principle, there is no difference in the sedimentation centrifuge procedure when it operates either in the dewatering or thickening mode. The scroll discharge solid bowl centrifuge also known as the decanter, commonly consists of a solid bowl made of two sections, one cylindrical and the other conical. It is popularly used in wastewater treatment. The disc-type centrifuge is largely used in the chemical and pharmaceutical industries and consists of a bowl with a vertical axis of rotation, usually composed of two elements for opening and cleaning purposes. (See also W90-08494) (Geiger-PTT)
W90-08508

ENVIRONMENTAL ASSESSMENT: MACKINAW RIVER DREDGED MATERIAL PLACEMENT SITE, LONZA, INC., (ILLINOIS RIVER MILE 147.8).
Army Engineer District, Rock Island, IL.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A203-554. Price codes: A03 in paper copy, A01 in microfiche. November 1988. 38p, 1 tab, 1 plate.

Descriptors: *Assessments, *Dredging wastes, *Mackinaw River, *Management planning, *Site selection, *Waste disposal, Waste management, Project planning, Illinois.

A 10-acre parcel of land (1,500 ft long and 100 to 300 ft wide) near Mapleton, Illinois was selected as the potential location for a new upland dredged material placement site for dredging activities in this vicinity. Situated between a highly developed industrial area and the Illinois River, the site is bordered by a Caterpillar Company levee on the west side and Pond Lily Lake (also known as Bootjack Lake) on the east side. Development of this site will facilitate the removal of material from the floodplain by pumping it to this upland placement site. The stockpiled material is then in an accessible location and can be removed at the discretion of the property owner. The preferred alternative involves clearing approximately 5 to 10 acres of trees and understory growth at the Lonza site before dredged material is placed there. The cleared material will be pushed into berms along the edge of the clearing and covered with hydraulically dredged material pumped from the mouth of the Mackinaw. The U-shaped configuration will contain the dredged material that is pumped into the area. The berms will extend some distance in front of where the material is actually being placed

to allow the material time to settle. After settling, the return effluent will flow out of the containment area, along Pond Lily Lake, and back to the Illinois River. Other alternatives explored included no action and the present dredging scheme. (Lantz-PTT)
W90-08557

IMPORTANCE OF CLIMATOLOGICAL VARIABILITY AND THE RATE AT WHICH WASTE IS ADDED TO MODELING WATER BUDGET OF LANDFILLS.
Tennessee Valley Authority, Norris. Engineering Lab.
S. C. Young, and R. B. Clapp.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-008917. Price codes: A03 in paper copy, A01 in microfiche. Report No. CONF-890262–2, (1988). 11 fig, 3 tab, 13 ref. TVA Interagency Agreement 1610-B056-A1 and DOE Contract DE-AC05-84OR21400.

Descriptors: *Hydrologic budget, *Landfills, *Mathematical models, *Model studies, *Soil water, *Waste disposal, Climatic data, Evapotranspiration, Meteorological data, Rainfall.

A transient one-dimensional wetting front model was developed to predict water budgets for landfills. The model simulates the moisture profile by a series of blocks, each of which has a uniform soil moisture content. The model can simulate the continual stacking of waste by adding blocks, which represent new waste layers, and can be programmed to build up a landfill at a given rate and to cap the landfill with a liner, once a specific height has been reached. The wetting front model has been compared with models that solve the Richards Equation directly. In past studies the results between the two types of models compared well, but the wetting front model solved problems with a fraction of the computer time. Because of its efficient algorithms, the wetting front model is well suited for Monte Carlo simulation of different meteorological conditions in order to produce probability density functions for runoff, evapotranspiration, and leachate generation. In order to simulate different meteorological conditions, the Tennessee Valley Authority (TVA) developed RGEN, which generates hourly rainfall, and EGEN which generates daily potential evaporation rates. In the simulations of the climate scenarios reported in this study, there was insufficient information either to generate a reliable probability density function for the drainage component, or to see simple relationships, like the effect of total rainfall on cumulative drainage at the bottom of the stack. Nevertheless, the high degree of variability evident in these simple simulations and the complexity of wetting front behavior suggests that the meteorological simulators EGEN and RGEN and the wetting front soil moisture model are the appropriate analytical tools for the tasks at hand. (Lantz-PTT)
W90-08562

ESTIMATION OF ENVIRONMENTAL RISK DUE TO POLLUTED SEDIMENT.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5C.
W90-08635

VIENNA SEWERAGE SYSTEM.
Vienna Municipal Dept., Austria.
For primary bibliographic entry see Field 5D.
W90-08636

5F. Water Treatment and Quality Alteration

EPA REGULATIONS FOR SURFACE WATER TREATMENT AND TOTAL COLIFORMS.
Dallas City Water Utilities Dept., TX. Wastewater Operation.
For primary bibliographic entry see Field 6E.
W90-07660

TWO-PHASE DECOMPOSITION METHOD FOR OPTIMAL DESIGN OF LOOPED WATER DISTRIBUTION NETWORKS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Industrial Engineering and Management.
O. Fujiwara, and D. B. Khang.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 539-549, April 1990. 3 fig, 7 tab, 30 ref, append.

Descriptors: *Looped water distribution networks, *Model studies, *Water distribution, Design criteria, Link flows, Optimal solutions, Pumping head, Two-phase decomposition method.

A two-phase decomposition method is proposed for the optimal design of new looped water distribution networks as well as for the parallel expansion of existing ones. The main feature of the method is that it generates a sequence of improving local optimal solutions. The first phase of the method takes a gradient approach with the flow distribution and pumping heads as decision variables and is an extension of the linear programming gradient method for nonlinear modeling. The technique is iterative and produces a local optimal solution. In the second phase the link head losses of this local optimal solution are fixed, and the resulting concave program is solved for the link flows and pumping heads; these then serve to restart the first phase to obtain an improved local optimal solution. The whole procedure continues until no further improvement can be achieved. (Author's abstract)
W90-07665

RAPID DETECTION OF CHLORINE-INDUCED BACTERIAL INJURY BY THE DIRECT VIABLE COUNT METHOD USING IMAGE ANALYSIS.
Montana State Univ., Bozeman. Dept. of Microbiology.
For primary bibliographic entry see Field 5A.
W90-07690

SMALL SEWAGE TREATMENT PLANTS AND WASTEWATER REUSE IN CYPRUS.
Hydrotech, Limassol (Cyprus).
For primary bibliographic entry see Field 5D.
W90-07772

DEPOSITION OF MANGANESE IN A DRINKING WATER DISTRIBUTION SYSTEM.
Queensland Univ., Brisbane (Australia). Dept. of Microbiology.
L. I. Sly, M. C. Hodgkinson, and V. Arunpairojana.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 3, p 628-639, March 1990. 12 fig, 5 tab, 25 ref.

Descriptors: *Drinking water, *Manganese, *Water mains, *Water treatment, Chemical precipitation, Chlorination, Chlorine, Disinfection, Water quality.

The deposition of Mn in a water distribution system with Mn-related 'dirty water' problems was studied over a 1-year period. Four monitoring laboratories with Robbins biofilm sampling devices fitted to the water mains were used to correlate the relationship among Mn deposition, the level of Mn in the water, and the chlorination conditions. Mn deposition occurred by both chemical and microbial processes. Chemical deposition occurred when Mn not removed during water treatment penetrated the filters and entered the distribution system, where it was oxidized by chlorine and chlorine dioxide used for disinfection. Microbial deposition occurred in areas with insufficient chlorination to control the growth of Mn-depositing biofilm. At 0.05 mg of Mn/L, the chemical deposition rate was much greater than microbial deposition. Significant deposition occurred at 0.03 mg Mn/L, and dirty water complaints were not eliminated until Mn levels were continuously <0.02 mg/L and chlorination levels were >0.2 mg/L. A guideline level of 0.01 mg Mn/L is recommended. (Author's abstract)
W90-07866

SHERLOCK HOLMES MEETS HARDY-CROSS, OR MODEL CALIBRATION IN AUSTIN, TEXAS.
Wyoming Valley Sanitary Authority, Wilkes-Barre, PA.
T. M. Walski.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 3, p 34-38, March 1990. 7 ref.

Descriptors: *Computer models, *Model studies, *Pipelines, *Water distribution, Austin, Computer programs, Model testing, Performance evaluation, Texas, Water conveyance.

Pipe model calibration for the water distribution system in the city of Austin, Texas often requires a great deal of detective work. The computer model of the system was originally set up in the early 1980s on a MicroVAX II computer using the WADSY computer program. Data collection for the model was carried out during the period of peak water use in August 1987. Fire hydrant flow tests were performed at 31 locations throughout the system. The exact water levels in the tanks and discharge settings of the pumps were recorded at the time of each test. During each test, the pressure record from some remote pressure transmitters was also noted. Observed and predicted heads were significantly different, indicating that the existing model was not a very accurate representation of the system. To recalibrate the model some discrepancies between model results and field observations could only be resolved by posing specific questions to valve crew supervisors, construction inspectors, and operations personnel. Several problems with the model were a result of the lag between installation of new mains and updating of system maps. As a result of recent model calibration work, the current computer model of the system accurately reflects what is occurring in the system. (Geiger-PTT)
W90-07892

SAVING COSTS WITH RESERVOIR PUMPED-WATER INTERTIES.
Ohio State Univ., Columbus. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3D.
W90-07894

EVALUATING LAYERED UPFLOW CARBON ADSORPTION FOR THE REMOVAL OF TRACE ORGANIC CONTAMINANTS.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
C. Munz, J.-L. Walther, G. Baldauf, M. Boller, and R. Bland.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 3, p 63-76, March 1990. 15 fig, 4 tab, 32 ref.

Descriptors: *Activated carbon, *Adsorption, *Chlorinated hydrocarbons, *Water quality control, *Water treatment, Drinking water, Granular activated carbon, Groundwater pollution, Model studies, Organic compounds, Phenols, Separation techniques, Water treatment facilities.

The layered upflow carbon adsorption (LUCA) system was compared with conventional fixed-bed adsorbers for removing chlorinated hydrocarbons from drinking water sources at the Porentruy pilot plant in Switzerland. During LUCA operation, the granular activated carbon (GAC) is added in thin layers, with a new layer being added whenever the maximum allowed effluent concentration of the contaminants is reached. Thus, the time of exposure of the GAC to dissolved organic carbon, which is known to reduce GAC's adsorption capacity of organic contaminants, is reduced. This mode of operation was found to produce approximately 50% longer operating times and correspondingly higher throughputs. When LUCA is implemented at Porentruy, the thickness of the first GAC layer will be 50-60 cm because of the relatively rapid initial breakthrough of the volatile organic carbons. For the subsequent layers, a thickness of 30 cm is considered appropriate. The

carbon lifetime in the LUCA adsorber is expected to be approximately doubled that of a fixed bed adsorber operated under similar conditions. LUCA has a few disadvantages. The LUCA adsorbers are generally more complicated to operate than conventional fixed-bed adsorbers, and require additional equipment and monitoring time. Also, the GAC needs to be backwashed in a separate container for the removal of carbon fines prior to its use. The average effluent quality will be poorer in a LUCA adsorber than in a fixed-bed adsorber. In contrast, LUCA is a relatively simple and cost-effective technology that significantly reduces the dissolved organic carbon preadsorption effect. (Geiger-PTT)
W90-07896

CONTACT AERATION FOR IRON REMOVAL: A THEORETICAL ASSESSMENT.
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Civil Engineering.
H. Z. Sarikaya.
Water Research WATRAG, Vol. 24, No. 3, p 329-331, March 1990. 1 fig, 1 tab, 9 ref.

Descriptors: *Iron, *Iron removal, *Water treatment, Aeration, Ferric iron, Hydrogen ion concentration, Reactor volume.

An iron removal process which makes use of the catalytic effect of ferric iron is proposed. Based upon the oxygenation rate equation, it has been theoretically demonstrated that the volumes of aeration tanks can be significantly reduced by keeping high concentration of ferric iron in the reactor. Ferric iron is more effective in reducing the reactor volumes at lower pH values. Recycling of ferric sludge is proposed to maintain the high ferric iron concentrations in the reactor. (Author's abstract)
W90-07914

SIMPLE ELUTION AND RECONCENTRATION TECHNIQUE FOR VIRUSES CONCENTRATED ON MEMBRANE FILTERS FROM DRINKING WATER SAMPLES.
National Environmental Engineering Research Inst., Nagpur (India).
For primary bibliographic entry see Field 5A.
W90-07921

PARTICULATE LEAD IN WATER SUPPLIES.
Water Research Centre, Swindon (England). Swindon Engineering Centre.
A. D. Hulsmann.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 19-25, February 1990. 1 fig, 4 tab, 10 ref.

Descriptors: *Lead, *Potable water, *Water pollution sources, *Water supply, Corrosion layer, European Commission, Hydraulics, Orthophosphates, Polyphosphates, Remedies, Size fractionation, Water conveyance.

Occasionally, failure to meet the European Commission standard for lead in drinking water is due to the presence of particulate lead. Size fractionation can distinguish between soluble, particulate, and colloidal lead. Two types of insoluble lead problems have been identified: particulate/colloidal lead, and flaking lead. The occurrence of flaking lead is caused by disturbance of the corrosion layer inside lead service pipes. Hydraulic circumstances have been identified as a causative factor, but other unidentified factors may also be involved. Remedial actions to combat particulate/colloidal lead aim at lowering iron concentrations in water, e.g. improved treatment, orthophosphate and polyphosphate dosing. In some cases a significant effect on lead concentration has been noticed. (Author's abstract)
W90-07929

PERFORMANCE OF FABRIC-PROTECTED SLOW SAND FILTERS TREATING A LOWLAND SURFACE WATER.
Dar es Salaam Univ. (Tanzania). Dept. of Civil Engineering.

T. S. A. Mbwette, M. A. R. Steitieh, and N. J. D. Graham.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 51-61, February 1990. 10 fig, 4 tab, 14 ref.

Descriptors: *Filtration, *Sand filters, *Water treatment, Fabric protected filters, Potable water.

The performance of slow sand filtration can be substantially improved by the application of a nonwoven synthetic fabric layer to the surface of the sand. By means of pilot-scale experiments, using the River Thames as the source water and pretreatment by sludge blanket clarifiers, the comparative performance of fabric-protected slow sand filters has been evaluated over an eight-month period. Under conditions designed to simulate poorly-controlled pretreatment, a correctly-specified fabric type, configuration and thickness can extend filter run times by a factor of 3-5 compared to a conventional slow sand filter. Furthermore, this can be achieved, together with the avoidance of any significant change in the hydraulic behavior of the sand, thereby avoiding the need to remove and clean sand. Fabric washing is relatively simple and efficient. (Author's abstract)
W90-07933

RENOVATING THE PUBLIC LABORATORY.
Laboratory Consultants, Albuquerque, NM.
D. W. Clark.
Public Works PUWOAH, Vol. 121, No. 3, p 46-59, 112-113, March 1990. 2 fig, 1 tab.

Descriptors: *Laboratories, *Laboratory renovation, *Wastewater facilities, *Water treatment facilities, Air flow, Cooling, Electrical equipment, Fume hoods, Heating, Sinks, Ventilation.

Many municipalities in the USA are being caught in a bind between aging water and wastewater treatment facilities on one hand and a shortage of Federal funds to replace them on the other. Often, the result is that the use of a particular treatment plant must now be extended beyond its original design lifetime through a combination of improved maintenance and judicious renovation. Specifications for analytical space, furnishings, and support services have shifted from meeting the demands of strictly chemical procedures to serving the more specialized needs of instrumental techniques. For the renovated laboratory, this requires especially careful attention to the redistribution of existing floor space, upgrading the facility's electrical services, and more strict control of the laboratory environment through heating, cooling, and ventilation to allow proper operation of sensitive equipment. When planning a renovation, models can be used for theoretical and objective utilization of space. Benches and other work areas should be located so they are readily accessible and with sufficient aisle space between them to permit convenient movement of laboratory carts and large pieces of equipment. Another feature to consider during renovation is the number and location of sinks to be installed, since sinks serve a variety of purposes, including sources of water for cooling systems and analytical uses, disposal sites for waste reagents, and places for washing glassware and cleaning up. Fume hoods are another aspect to consider, since they prevent the release of hazardous or noxious fumes, dusts, and gases into the laboratory. They must be located away from disturbances and air currents that might affect air flow across the face of the hood. Heating and cooling may be accomplished either in conjunction with a central ventilation system or independently, depending upon the needs of the laboratory. Good lighting is of paramount importance in a laboratory, as well, and any inadequacies should be corrected during renovation. (Brunone-PTT)
W90-07946

LINING UP AGAINST OIL.
Smith-Emery Co., Los Angeles, CA.
For primary bibliographic entry see Field 8A.
W90-07962

CRITICAL REVIEW OF METHODS USED FOR THE SENSORY EVALUATION OF WATER QUALITY.
California Univ., Berkeley. Dept. of Social Administrative Health Services.
For primary bibliographic entry see Field 5A.
W90-07963

REACTION OF ORGANIC NITROGEN COMPOUNDS WITH CHLORINE AND CHLORINE DIOXIDE.
Howard Univ., Washington, DC. Dept. of Civil Engineering.
M. M. Varma, F. R. Niles, and J. H. Johnson.
Journal of Environmental Systems JEVSBH, Vol. 19, No. 1, p 33-43, 1989/90. 5 fig, 3 tab, 19 ref.

Descriptors: *Chlorine, *Chlorine dioxide, *Disinfection, *Nitrogen compounds, *Wastewater treatment, *Water treatment, Chlorination, DNA, Mutagens, Organic compounds.

Since the effect at the cellular level of chlorine or chlorine dioxide disinfection is not well understood at this time, the chemical action of these agents upon the organic nitrogen compounds adenine, cytosine, thymine, and uracil was evaluated. When chlorine and chlorine dioxide were separately interacted with these compounds in the concentration range 0.001-0.28 mmol/l, chlorine exhibited a higher selectivity for cytosine and thymine when the concentrations of nitrogenous compounds were held constant. Under similar conditions, there were no reactions with chlorine dioxide. These findings may help provide an understanding of chlorine-DNA dynamics and the resulting mutagenic effect, and the associated health impacts of disinfecting municipal and wastewater by chlorination. (Author's abstract)
W90-08008

TRIHALOMETHANES (THMS) FORMATION IN MULTI-STAGE FLASH (MSF) DISTILLATION PLANTS.
Kuwait Water Resources Development Centre, Safat.
For primary bibliographic entry see Field 3A.
W90-08050

PREDICTIVE MODEL TO FIND THE OPTIMUM CHLORINE TREATMENT SCENARIO FOR BIOFOULING CONTROL.
Kuwaiti Tech Consultance, Faiha.
A. Al-Hoti.
Desalination DSLNAH, Vol. 74, No. 1/3, p 227-241, November 1989. 3 fig, 30 ref.

Descriptors: *Chlorination, *Condensers, *Fouling, *Industrial water, *Powerplants, Bacteria, Disinfection, Florida, Kinetics, Model studies, New Jersey, New York, Prediction, Saline water, Water treatment.

A phenomenological model was developed to predict bacterial biofouling control in power plant condensers using chlorine. The model uses background fouling information to calibrate the control growth component and the fouling response of a treated condenser to calibrate the film destruction component. Disinfection kinetics of the total flora then are developed for the cooling water using various chlorine concentrations. These disinfection kinetics are then correlated to the destruction component of the treated condenser tube, and time-variable transformation coefficients are generated. Once the coefficients are developed, any chlorination scenario (e.g., chlorine concentration, contact time, or number of applications per day) can be input to the model and fouling predictions made. The result is a response surface that predicts fouling for any chlorination scenario. The model was tested at different sites with different cooling water salinity (Albany Steam Station, Albany, NY; Biscayne Bay, Miami, FL; and Oyster Creek Nuclear Power Plant, NJ). The water showed high reliability for predicting the response to different chlorine treatment scenarios used in minimization studies at these three locations. The model overestimated fouling in some treatments. The model's predic-

tions about fouling in the system are sufficient to keep power plant condensers clean and to minimize the chlorine discharge to receiving waters. (Rochester-PTT)
W90-08051

MONITORING OF ORGANIC COMPOUNDS IN FEED AND PRODUCT WATER SAMPLES FROM MSF PLANTS IN THE EASTERN COAST OF SAUDI ARABIA.
Saline Water Conversion Corp., Al-Jubail (Saudi Arabia). Research, Development and Training Center.
For primary bibliographic entry see Field 3A.
W90-08052

DRINKING WATER AND HEALTH: DISINFECTANTS AND DISINFECTANT BY-PRODUCTS.
National Research Council, Washington, DC. Safe Drinking Water Committee.
For primary bibliographic entry see Field 5C.
W90-08156

WATER DISTRIBUTION SYSTEMS: A TROUBLESHOOTING MANUAL.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
J. W. Male, and T. M. Walski.
Lewis Publishers, Chelsea, Michigan. 1990. 107p.

Descriptors: *Handbooks, *Maintenance, *Water distribution, Hydraulic structures, Pipes, Valves.

The primary purpose of the book is to help the water utility employee who is faced with a new problem. It is designed to lead the employee through identification of the problem and selection of a solution. Topics covered in this handbook encompass a broad range of aspects of the water distribution system, including pipes, valves, hydrants, pumps, and storage tanks. The emphasis of the handbook is on problems and solutions associated with existing systems. The handbook does not discuss design considerations, except as they pertain to upgrading the existing system. The repair, rehabilitation, and replacement of system components are addressed. The handbook is organized as follows. Chapter 2 emphasizes the analysis of distribution systems to determine what kind of problems exist and to identify the types and extent of the problems. Chapter 2 also discusses information that can be collected, maintained, and analyzed to manage a distribution system properly. The underlying causes of problems are discussed in Chapter 3, while Chapter 4 presents approaches that can be used to address problems. Chapter 5 provides guidance on selecting the best remedy for a specific problem or set of problems. (Lantz-PTT)
W90-08159

ENSURING THE VIABILITY OF NEW, SMALL DRINKING WATER SYSTEMS: A STUDY OF STATE PROGRAMS.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-187413. Price codes: A07 in paper copy, A01 in microfiche. Report No. EPA-570/9-89-004, April 1989. 122p, 14 fig.

Descriptors: *Connecticut, *Drinking water, *Georgia, *Maryland, *State jurisdiction, *Washington, *Water supply development, *Water treatment, Long-term planning, Permits, Public policy, Regulations, Water supply.

In the past two years, State drinking water programs have shown a heightened interest in limiting the creation of new small systems that are non-viable. By 'non-viable' we refer to systems with technical, financial, or managerial weaknesses that may render them incapable of complying with drinking water regulations. In response to this interest, the EPA Office of Drinking Water asked a private firm to prepare a study of State programs in this area and to disseminate the results of this study to the States. Four states were selected to be case studies: Connecticut, Georgia, Maryland, and Washington. They were chosen to provide geo-

graphic, demographic, and programmatic diversity. Interviews with state and county administrators and detailed reviews of statutes, regulations, and case studies formed the basis of the research. Permitting and planning processes, such as those of Connecticut, Maryland, and Washington, can be used to evaluate whether proposed systems can be interconnected with existing systems or could be run better through satellite management. Georgia's permitting process, although restricted in scope, encourages small privately owned systems to consider connecting to nearby publicly owned ones. In the States studied, these efforts decrease the number of new small systems created, thereby reducing the likelihood of small system non-viability. In three of the states studied, the role of water supply planning is recognized as a means of addressing current and future problems in an orderly manner. Of the controls examined in this study, satellite management and ownership appears to be the most effective and efficient way to increase the likelihood of viable water service in isolated areas where interconnections are not feasible. Programs to control the creation of potentially non-viable drinking water systems are best developed at the State and local levels of government. As shown in this report, these programs often are part of broader state-wide policies concerning land use planning, economic development, and natural resources management. EPA's interest in this issue is best served through two types of activities. First, working with the states, EPA should encourage the dissemination of information about successful control programs. Second, EPA can adapt a strategy favoring development of programs to control creation of non-viable systems. Once such a strategy is established, EPA Regional Offices can work with states to encourage development of such programs. (Lantz-PTT)
W90-08168

DRINKING WATER CRITERIA DOCUMENT FOR ASBESTOS.
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-192074. Price codes: A09 in paper copy, A01 in microfiche. Report No. ECAO-CIN-422, March 1985. 181p, 3 fig, 18 tab, 175 ref, append.

Descriptors: *Asbestos, *Drinking water, *Literature review, *Public health, *Water pollution effects, Chemical properties, Physical properties, Toxicity.

The Office of Drinking Water, Environmental Protection Agency, has prepared a Drinking Water Criteria Document on Asbestos. This Criteria Document is an extensive literature review of the following topics: physical and chemical properties of asbestos; toxicokinetics and human exposure to asbestos; health effects of asbestos in humans and animals; mechanisms of toxicity of asbestos; and quantification of toxicological effects of asbestos. (Author's abstract)
W90-08169

DRINKING WATER CRITERIA DOCUMENT FOR ALDICARB.
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-192066. Price codes: A09 in paper copy, A01 in microfiche. Report No. ECAO-CIN-420, January 1988. 170p, 3 fig, 26 tab, 119 ref, append.

Descriptors: *Aldicarb, *Drinking water, *Literature review, *Public health, *Water pollution effects, Chemical properties, Pesticides, Physical properties, Toxicity.

The Office of Drinking Water, Environmental Protection Agency, has prepared a Drinking Water Criteria Document on Aldicarb. This Criteria Document is an extensive literature review of the following topics: physical and chemical properties of aldicarb; toxicokinetics and human expo-

sure to aldicarb; health effects of aldicarb in humans and animals; mechanisms of toxicological effects of aldicarb; and quantification of toxicological effects of aldicarb. (Author's abstract)
W90-08170

SCREENING EQUIPMENT HANDBOOK: FOR INDUSTRIAL AND MUNICIPAL WATER AND WASTEWATER TREATMENT.
For primary bibliographic entry see Field 5D.
W90-08175

WATER SUPPLY.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark.
IN: Standard Handbook of Environmental Engineering. McGraw-Hill Publishing Co., New York, New York. 1990. p 259-483, 84 fig, 54 tab, 121 ref.

Descriptors: *Water resources development, *Water supply, Groundwater budget, Groundwater mining, Saline water, Surface water, Water conveyance, Water demand, Water quality, Water treatment.

The nation's water resources have been extensively developed to satisfy a variety of beneficial uses. Water projects generally support a dominant single purpose, such as urban water supply, irrigation, flood control, or navigation. Water withdrawn for off-stream use consists of two variables: (1) the part returned to the surface water or groundwater source after being used, and (2) the part consumed but not returned to the source after use. A typical example of consumption is vegetation transpiration. Much of the water used for irrigation, particularly sprinkler irrigation, either is transpired by plants or is evaporated from the soil. Withdrawals may include saline water, but the major concern of this discussion is with freshwater withdrawals and consumption for each category of use. This chapter deals with the following water supply related issues: demand, quality, sources, groundwater production, surface water collection, surface water treatment, saline water production, nonconventional water production, and distribution. (See also W90-08177) (Lantz-PTT)
W90-08181

RELIABILITY-CONSTRAINED PIPE NETWORK MODEL.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W90-08210

RELIABILITY ANALYSIS OF PUMPING SYSTEMS.
Chinese Academy of Environmental Sciences, Beijing.
For primary bibliographic entry see Field 8C.
W90-08211

EVALUATION OF AIR STRIPPING FOR THE REMOVAL OF ORGANIC DRINKING-WATER CONTAMINANTS.
Geustyn, Forsyth and Joubert, Inc., Pretoria (South Africa).
J. Haarhoff, and J. L. Cleasby.
Water SA WASADV, Vol. 16, No. 1, p 13-22, January 1990. 6 fig, 3 tab, 17 ref, 2 append.

Descriptors: *Air stripping, *Drinking water, *Organic pollutants, *Water treatment, Decontamination, Design criteria, Hydraulic engineering, Performance evaluation.

Counter-current air stripping has emerged as one of the simplest and most effective technologies for reducing the level of organic contaminants in drinking water. Air stripping theory was applied to a broad range of organic contaminants which are of present concern to the water treatment industry. It demonstrated that Henry's constant is by far the most important parameter that affects the ease of stripping of a contaminant. Three categories of

contaminants were identified; those which are not amenable to air stripping at all, those that are very easily stripped under almost any conditions; and a transitional group for which the stripping tower design must be carefully optimized for good results. It was found that air stripping towers, with a judicious but practical choice of design parameters, are capable of practically complete removal of 58% of 48 organic drinking water contaminants considered. A compilation of commercial packing properties demonstrated that the specific packing area and the air friction factor both decrease quite sharply as nominal packing size increases, and the generalized curves are useful for preliminary designs. (Fish-PTT)
W90-08228

BIOLOGICAL TREATMENT OF PUBLIC WATER SUPPLIES.
Illinois Univ., Urbana. Dept. of Civil Engineering.
B. E. Rittman, and P. M. Huck.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 2, p 119-184, 1989. 17 fig, 21 tab, 237 ref.

Descriptors: *Biological treatment, *Drinking water, *Literature review, *Water supply, *Water treatment, Ammonia, Biodegradation, Carbon filters, Chlorination, Europe, Filtration, Iron, Manganese, Nitrates, Organic matter, Organic pollutants, Ozonation, Sand filters, Water distribution, Water treatment facilities.

The increasing pressure to provide a safe and aesthetically pleasing drinking water to all consumers should force practices in North America to move away from chlorination and toward more biological treatment, as is already occurring in western Europe. Particular concerns driving the changes are chlorination byproducts, regrowth in the distribution system, and organic micropollutants. For application of biological treatment in North America, the removal of organic matter, ammonia, nitrate, iron, and manganese are appropriate because each of these contaminants is present in widespread areas. The options of ground treatment and slow sand filtration are not feasible for many medium-sized or large-sized waterworks in North America, although they appear attractive for small facilities. The use of in situ techniques requires suitable subsurface conditions, the absence of prior contamination of the site, and a requirement to protect the subsurface area from future contamination. The use of biologically active granular activated carbon filters, with or without preozonation, is a viable option for the medium and large waterworks. For all-sized plants, the option of an engineered biological process is attractive when one or more of the biodegradable contaminants is present in significant concentrations. Research is needed to evaluate the available techniques for measurement of biodegradable organic matter, and, if necessary, develop an improved technique for North America. (Fish-PTT)
W90-08321

DECOMPOSITION OF LARGE WATER-DISTRIBUTION SYSTEMS.
Roorkee Univ. (India). Dept. of Civil Engineering.
P. K. Swamee, and A. K. Sharma.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 269-283, March/April 1990. 3 fig, 9 tab, 2 ref.

Descriptors: *Computer-aided design, *Network design, *Water distribution, Algorithms, Computer programs.

Designing a large water distribution network as a single entity is difficult. The present practice of designing such a system is by decomposing or splitting it into a number of subsystems. Each subsystem is separately designed and finally connected at the ends for reliability. The decision regarding the area to be covered by each subsystem depends on the designer's intuition. Similarly, on computers, designing a large water distribution system as a single entity is difficult in terms of computer time and storage. Such a system can also be efficiently designed on computers if divided into small subsystems. An algorithm is presented that

divides a large water distribution system of predecided multiple-input points into small subsystems of single input. The algorithm will not only eliminate the present practice of decomposing or splitting by designer's intuition but also enable the designer to design a large water distribution system with a reasonable computation effort. (Author's abstract)
W90-08343

ASSESSING POLYELECTROLYTE BEHAVIOR BY SIZE-EXCLUSION CHROMATOGRAPHY.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-08348

MINIMIZING CHLORITE ION AND CHLORATE ION IN WATER TREATED WITH CHLORINE DIOXIDE.
Miami Univ., Oxford, OH. Dept. of Chemistry.
G. Gordon, B. Slootmaekers, S. Tachiyashiki, and D. W. Wood.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 4, p 160-165, April 1990. 3 tab, 32 ref.

Descriptors: *Chemical treatment, *Chlorination, *Chlorine dioxide, *Potable water, *Water chemistry, *Water treatment, Analytical methods, Chlorate, Chlorite, Water analysis.

Minimizing the inorganic by-products chlorite ion and chlorate ion (ClO2) in drinking water treated with chlorine dioxide is important if ClO2 is to remain a viable alternative in potable water treatment. Highly sensitive analytical methods were used at the submilligram-per-liter level for the determination of chlorine dioxide, free chlorine, chlorite ion, and chlorate ion. Chlorate ion in the finished water can be controlled by-proper chlorine dioxide generation and by removing the chlorite ion by product prior to postchlorination. Chlorite ion and chlorine dioxide can be removed by treatment with a reducing agent such as sulfur dioxide-sulfite ion at pH values of 5-7 in a matter of minutes, and the excess reducing rate can be removed by postchlorination. Using the stoichiometry and the rate law for pH values of 5.5 to 8.5 the chemistry can be applied directly in existing drinking water treatment facilities. (Chonka-PTT)
W90-08370

HOUSEHOLD ODORS ASSOCIATED WITH THE USE OF CHLORINE DIOXIDE.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
R. C. Hoehn, A. M. Dietrich, W. S. Farmer, M. P. Orr, and R. G. Lee.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 4, p 166-172, April 1990. 1 tab, 13 ref.

Descriptors: *Chlorination, *Chlorine dioxide, *Odor control, *Odors, *Water treatment, Air-water interfaces, Ammonification, Organic compounds.

Reports have indicated that the use of chlorine dioxide (ClO2) instead of chlorine as a preoxidant during water treatment is related to the production of offensive odors at customers' homes and businesses. These odors were described by terms such as 'kerosenelike,' 'cat-urine like' and 'strong chlorinous.' Attempts to isolate and identify the odor-causing compounds in water samples taken from treatment plants and homes were unsuccessful. Suggestions from others that the offensive odors were in some way related to the presence of new carpeting in homes and businesses provided the basis for additional experiments. Based on currently available data, the following conclusions were drawn: (1) ClO2 can be regenerated from chlorite either directly or indirectly by reactions with hypochlorous acid and is the likely cause of strong chlorinous odors detected in the distribution system at times when ClO2 is being applied at the water treatment plant, even though concentrations at the tap are quite low (less than 0.2 mg/L); (2) The kerosenelike and cat urine-like odors can be

produced by reactions between ClO2 escaping from water and organic compounds in household air. The specific compounds involved are unknown at this time; (3) New carpeting is a common source of the organic compounds that are precursors to the offensive odors noted in the distribution systems of water treatment plants in which ClO2 is being applied. It is likely, however, that there are other sources of the precursor organics; (4) The odor problems associated with ClO2 can be prevented if either free residual chlorine or chlorate is removed from the water. Ammoniation to form chloramines after chlorination should eliminate the odor problems by removing free chlorine as a potential reactant with the residual chlorite. (Chonka-PTT)
W90-08371

CHLORINATION BY-PRODUCTS IN DRINKING WATERS: FROM FORMATION POTENTIALS TO FINISHED WATER CONCENTRATIONS.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
D. A. Reckhow, and P. C. Singer.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 4, p 173-180, April 1990. 7 fig, 9 tab, 57 ref. EPA Grant R-810235.

Descriptors: *Chlorination, *Fulvic acids, *Humic acids, *Potable water, *Raw water, *Trihalomethanes, *Water treatment, Alum coagulation, By-products.

An attempt was made to bridge a portion of the gap between formation potentials in model systems, e.g., solutions of humic substances, and by-product concentrations likely to be encountered in finished waters. The experimental objectives of the research were (1) to compare the formation of chlorination by-products from colored natural waters and from extracted aquatic humic substances, and (2) to examine the effects of alum coagulation on the quantity and distribution of chlorination by-products. The chlorination by-products chosen for study were trihalomethanes (THMs), total organic halide (TOX), trichloroacetic acid (TCAA), dichloroacetic acid (DCAA) 1,1,1-trichloroacetone (TCAC), and dichloroacetonitrile (DCAN). Raw and treated waters from 10 plants were used in the study. Chlorination of colored natural waters gives yields of specific halogenated by-products that are quite similar to those measured as a result of the chlorination of isolated aquatic humic substances. This is true for TCAA, DCAA, TCAC, and DCAN, as well as THMs and TOX. Alum coagulation effectively removes significant fractions of all the precursor types tested. For a moderately colored water, more than 60% of most of the precursors could be removed. The spectrum of chlorination by-products in finished drinking waters reflects the raw-water formation potentials, the selective effects of precursor removal by treatment processes, and the particular reaction conditions of chlorination. Hydrophobic organic fractions, e.g., humic acids, are especially rich in precursors to TCAA and DCAN and poor in precursors to TCAC. As a result, alum coagulation leads to better removal of TCAA formation potential (TCAAFP) and DCAN formation potential (DCANFP) compared with the removal of other organohalide precursors, e.g., THMFP and TOXFP. In contrast, TCACFP is more poorly removed than the THMFP or TOXFP. These effects can lead to a drop in the mass ratio of TCAAFP to THMFP from 1.3 to 0.5 across coagulation, whereas the TCACFP:THMFP ratio may increase from 0.02 to 0.04. Observations such as these may be used to explain the concentrations of by-products in finished waters. (Chonka-PTT)
W90-08372

COMPARING PEROXONE AND OZONE FOR CONTROLLING TASTE AND ODOR COMPOUNDS, DISINFECTION BY-PRODUCTS, AND MICROORGANISMS.
Southern California Metropolitan Water District, La Verne.
D. W. Ferguson, M. J. McGuire, B. Koch, R. L. Wolfe, and E. M. Aieta.

Journal of the American Water Works Association JAWWA5, Vol. 82, No. 4, p 181-191, April 1990. 18 fig, 5 tab, 26 ref.

Descriptors: *Analytical methods, *Disinfection, *Hydrogen peroxide-ozone, *Odor control, *Oxidation process, *Ozone, *Taste, *Water quality, *Water treatment, Byproducts, California State Water Project, Colorado River, Comparison studies, Data collections, Microorganisms.

The Metropolitan Water District of Southern California evaluated the hydrogen peroxide-ozone (PEROXONE) advanced oxidation process (followed by secondary disinfection with chloramines) for removal of taste and odor compounds, control of disinfection by-products (DBPs), and inactivation of microorganisms. Pilot-scale testing was designed to optimize the H2O2:O3 ratio and to compare ozone and PEROXONE at different contact times. The tests represent one phase of a five-phase PEROXONE pilot-scale study for treating water from the California State Water Project and from the Colorado River. Results indicate that the PEROXONE process requires a significantly lower applied ozone dosage to oxidize 2-methylisoborneol and geosmin as compared with ozone alone. The levels of DBPs formed when ozone or PEROXONE is used (followed by chloramines) are low, and PEROXONE (at H2O2:O3 ratios of less than or = to 0.3) is comparable with ozone for the inactivation of microorganisms. (Chonka-PTT)
W90-08373

DETERMINING INORGANIC DISINFECTION BY-PRODUCTS BY ION CHROMATOGRAPHY.
Environmental Monitoring Systems Lab., Cincinnati, OH.
J. D. Pfaff, and C. A. Brockhoff.
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 4, p 192-195, April 1990. 2 fig, 5 tab, 6 ref.

Descriptors: *Analytical methods, *Byproducts, *Byproducts, *Disinfection, *Chemical analysis, *Ion exchange chromatography, *Water analysis, *Water treatment, Bromate, Chlorate, Chlorite, Nitrates, Nitrites.

Disinfection by-products will soon be regulated by the US Environmental Protection Agency under the 1986 amendments to the Safe Drinking Water Act. Because of its sensitivity and precision, ion chromatography is a good choice for analyzing byproducts of chlorine dioxide and ozone. The inorganic disinfection by-products of chlorite, chlorate and bromate can be determined in a single run on an ion chromatograph. Other anions such as chloride, nitrite, nitrate, and sulfate can also be determined in the same run of about 25 minutes. The iodate by-product cannot be determined because it coelutes with fluoride under the conditions used in this method. Any analyst interested in iodate could modify the procedure by weakening the eluant, which will separate the fluoride and iodate. However, sulfate would then be retained for an unacceptably long time. Another possibility would be to use UV detection to measure the iodate. Ion chromatography is acceptable to the USEPA for the determination of nitrate in drinking waters and will shortly receive approval for nitrite. (Chonka-PTT)
W90-08374

REACTIONS OF FREE CHLORINE WITH SUBSTITUTED ANILINES IN AQUEOUS SOLUTION AND ON GRANULAR ACTIVATED CARBON.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
S. C. Hwang, R. A. Larson, and V. L. Snoeyink.
Water Research WATRAG, Vol. 24, No. 4, p 427-432, April 1990. 3 fig, 2 tab, 24 ref.

Descriptors: *Activated carbon, *Chlorination, *Wastewater treatment, *Water treatment, Acylation, Aromatic compounds, Chemical analysis, Chemical reactions, Debromination, Dyes.

Aqueous HOCl reacted with substituted anilines to form chlorinated derivatives. Some debromination

and bromination products were also detected from two brominated anilines. When granular activated carbon (GAC) was present, many additional products were formed. These compounds fall into several groups: (1) N-acylation products, (2) N-carbomethoxylation products, (3) N=N dimerization products and (4) deamination and hydroxylation products. The formation of azobenzene (N=N dimers) is particularly important, because of their potential toxicity. Such compounds are the major reaction products of chlorine with anilines in the presence of GAC. Debromination reactions apparently did not occur to a significant extent on carbon with the substrates tested. No products were detected from GAC columns receiving halogen-substituted and unsubstituted anilines. However, 4,4'-dimethylazobenzene and an unknown compound were formed from p-toluidine on GAC, which indicates some reactive free radicals on the carbon surface present without requiring oxidation with chlorine or other oxidants. (Author's abstract)
W90-08383

SOME FURTHER STUDIES ON FACTORS AFFECTING THE LEACHING OF LEAD FROM UNPLASTICIZED POLY (VINYL CHLORIDE) PIPES.
National Univ. of Singapore. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W90-08387

COMPARISON OF TWO PARTIALLY ACTIVATED CARBON FABRICS FOR THE REMOVAL OF CHLORINE AND OTHER IMPURITIES FROM WATER.
Birmingham Univ. (England). Dept. of Civil Engineering.
R. J. Martin, and R. C. Shackleton.
Water Research WATRAG, Vol. 24, No. 4, p 477-484, April 1990. 2 fig, 6 tab, 17 ref.

Descriptors: *Carbon filters, *Drinking water, *Filter media, *Filters, *Taste, *Water treatment, Activated carbon, Comparison studies, Domestic water, Water quality.

Experimentals were undertaken to investigate and compare the use of two partially activated carbon fabrics for the removal of chlorine and other impurities from potable water in domestic point-of-use filters. Since the implementation of the European Economic Community (EEC) drinking water quality directive in July 1985, there has been a marketing surge in domestic filters, generally aimed at improving taste (the taste of chlorine is frequently cited). The fabrics were very effective at removing chlorine (> 90% removal) from water; their dechlorinating powers were significantly superior to those of the granular activated carbon used for comparison. The fabrics were much less effective at removing phenol, methylene blue and color. (Author's abstract)
W90-08391

DISTRIBUTION OF HALOMETHANES IN POTABLE WATERS OF KUWAIT.
Liverpool Univ. (England). Dept. of Oceanography.
M.A. Ali, and J.P. Riley.
Water Research WATRAG, Vol. 24, No. 4, p 533-538, April 1990. 3 fig, 5 tab, 21 ref.

Descriptors: *Desalination, *Drinking water, *Kuwait, *Potable water, *Trihalomethanes, *Water treatment, Brominated hydrocarbons, Chlorination, Data collections, Water quality standards, Water sampling.

The distribution of bromine containing trihalomethanes was measured in the water distribution system of Kuwait from the desalination plant through the distribution and storage system to the user's tap. Total halomethanes in the drinking water averaged 25.6 +/-9.1 micrograms/L with a maximum of 50.5 micrograms/L. Average concentrations of individual compounds in micrograms/L were: CHBr3, 13.6 +/-4.6; CHBr2Cl, 8.8 +/-3.7; CHCl2Br, 3.3 +/-1.5. These values are well below both the maximum contaminant limit of 100 micrograms/L set by the U.S. Environmental Protection

Agency and most of the levels found in its National Organics Monitoring Survey project. The compounds present are dominated not by chloroform as in the EPA surveys, but by the brominated species whose toxicities have not yet been as well studied. Water from roof top storage tanks contained significantly less halomethanes than that from underground reservoirs. (Chonka-PPT)
W90-08399

OZONATION OF SEVERAL ORGANIC COMPOUNDS HAVING LOW MOLECULAR WEIGHT UNDER ULTRAVIOLET IRRADIATION.
National Research Inst. for Pollution and Resources, Yatabe (Japan).
For primary bibliographic entry see Field 5D.
W90-08453

OXIDATION OF PARACHLORONITROBENZENE IN DILUTE AQUEOUS SOLUTION BY O3 + UV AND H2O2 + UV: A COMPARATIVE STUDY.
Poitiers Univ. (France). Lab. de Chimie de l'Eau et des Nuisances.
S. Guittonneau, J. De Laat, J. P. Duguet, C. Bonnel, and M. Dore.
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 1, p 73-94, 1990. 12 fig, 6 tab, 19 ref.

Descriptors: *Hydrogen peroxide, *Nitrobenzenes, *Ozonation, *Ultraviolet radiation, *Water treatment, Aromatic compounds, Chloronitrobenzene, Drinking water, Groundwater pollution, Organic compounds, Oxidation, Quality control.

Nitrobenzene compounds are widely used in chemical industries and recently have been associated with groundwater contamination. The production of drinking water from contaminated waters requires sophisticated treatments to remove these compounds. Advanced oxidation processes involving the generation of very reactive and oxidizing hydroxyl free radicals can be achieved by the combinations of ozone, hydrogen peroxide, and ultraviolet radiation (O3/UV; H2O2/UV; O3/H2O2). The efficiency of these oxidation processes depends on the various parameters, such as oxidant dose, UV light intensity, contact time, nature of the organic pollutants, etc. and are significantly affected by the alkalinity. This study was designed to investigate the degradation of a nitroaromatic compound, 4-chloronitrobenzene (CNB), in water (pH = 7.5) by ultraviolet radiation (UV) in combination with hydrogen peroxide (H2O2) or aqueous ozone (O3), and to compare the efficiency of these two oxidation processes. The study shows that CNB may be degraded by H2O2/UV and by O3/UV processes. The efficiencies of these processes increase as the oxidant dose and as the irradiation time increase, and significantly decrease in the presence of bicarbonate ions. The difference between the efficiency of the H2O2/UV and O3/Uv systems for CNB removal may be attributed to the fact that the photolysis of H2O2 and O3 presents different generation rates and different yields for the production of hydroxyl free radicals. However, for a given amount of oxidant decomposed, the H2O2/UV system was found to be more efficient than O3/UV. Because of the complicated nature of the reactions involved in these processes, and in particular photolytic ozonation, a kinetic model is needed in order to optimize the operating conditions under which these oxidations could be carried out and to determine treatment costs. (Agostine-PTT)
W90-08454

SLOW SAND FILTRATION: RECENT DEVELOPMENTS IN WATER TREATMENT TECHNOLOGY.
John Wiley and Sons, New York, New York. 1988. 416 p. Edited by N. J. D. Graham.

Descriptors: *Filtration, *Sand filters, *Slow sand filtration, *Symposium, *Technology, *Water treatment, Case studies, Design criteria, Developing countries, Performance evaluation.

This book presents recent research and state-of-the-art information on the scientific basis, modes of use, and engineering developments of slow sand filtration. The information, based on presentations made at the International Seminar 'Advances in Slow Sand Filtration' held in London November 23-25, 1988, is grouped into the following themes: filter design, operation and management; pretreatment methods; biological aspects; process performance; process developments; and developing country case studies. Slow sand filtration is an effective water treatment unit process. However, its low-technology image and perceived disadvantages (e.g. low throughput, high operation and maintenance costs) have resulted in it being considered generally inappropriate as a treatment alternative for industrialized countries. Such perceptions are now rapidly changing in the light of the rising need to meet higher drinking water quality standards. In developing countries slow sand filters are well established as an appropriate treatment technology. However, many installations fail as a result of inadequate pretreatment facilities, lack of a proper understanding of the process, and poor operation and maintenance practice. This book brings together the experience and knowledge from a broad spectrum of related disciplines, such as plant operators and designers, universities and research organizations to focus on and summarize the latest understanding and developments in sand filtration. (See W90-08471 thru W90-08493) (Geiger-PTT)
W90-08470

WATER TREATMENT BY SLOW SAND FILTRATION: CONSIDERATIONS FOR DESIGN, OPERATION AND MAINTENANCE.
International Reference Centre for Community Water Supply and Sanitation, The Hague (Netherlands).
J. T. Visscher.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 1-10. 5 fig. 7 ref.

Descriptors: *Filtration, *Maintenance, *Operating policies, *Sand filters, *Slow sand filtration, *Water treatment, Construction methods, Cost analysis, Design criteria, Developing countries, Operating costs, Rural areas.

Slow sand filters because of their advantage of simplicity, efficiency and economy are appropriate means of water treatment, particularly for community water supply in developing countries. The basic elements of a slow sand filter include a box constructed of reinforced concrete, ferrocement and stone or brickwork masonry containing a supernatant layer of raw water, a bed of fine sand, a system of underdrains, an inlet and outlet structure, and a set of filter regulation and control devices. The water flow in a slow sand filter may be controlled at the outlet, or at the inlet of the filter, and the method chosen may slightly affect the structure, the control devices and the functioning. As there is hardly any economy of scale in the cost of slow sand filter construction, short design periods of 10-15 yr can be adopted. For surface water, operation at a rate between 0.1 and 0.2 cu m/sq m/hr is usually satisfactory, because the filter tends to clog within a shorter period of time using higher rates of filtration. It is most effective to operate a slow sand filter continuously because good quality effluent is ensured, and the smallest filter area is required. At least two slow sand filter units are required to ensure uninterrupted supply and facilitate maintenance. For rural areas it is advisable to restrict the area per filter unit to 200 sq m to facilitate filter cleaning. The construction cost of a filter excluding pipes and valves is made up of two components: the total cost for floor, underdrains, sand, and gravel; and the cost of walls of the filter box. The construction cost of small and medium sized slow sand filters often will be less than that of other types of treatment. The simplicity of operation and maintenance of slow sand filters make them particularly appropriate for rural areas where local people can do the job. The daily operation of the filter is limited to checking and possibly adjusting the rate of filtration and monitoring plant performance and effluent quality. Re-sanding of the

filter becomes necessary when successive scrapings during cleanings have reduced the thickness of the sand bed to 0.5-0.6 m. (See also W90-08470) (Geiger-PTT)
W90-08471

SLOW SAND FILTRATION: AN APPROACH TO PRACTICAL ISSUES.
Thames Water Authority, London (England). Regional Lab. Services.
I. P. Toms, and R. G. Bayley.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 11-28. 6 fig, 3 tab, 9 ref.

Descriptors: *Filtration, *Operating policies, *Sand filters, *Slow sand filtration, *Water treatment, Algae, Disinfection, England, Escherichia coli, Hydraulic models, Maintenance, Model studies, Water quality.

The Thames Water Authority and its predecessors have over fifty years experience in advising on the use and design of slow sand filters. As filtration rates increased, the traditional water quality determinants of bacteria and turbidity were supplemented with determinants more sensitive to process behavior such as particulate organic carbon, chlorophyll a, total particulate nitrogen, and microscopic examination. Statistical analysis of hydraulic data was used to build models of filtration. Modeling showed the importance of minimizing the normalized starting head-loss particularly when filters are uprated. This, in turn, required minimum standards of cleanliness for sand media. The hydraulic and analytical data should be used in advising on the management of resanding and sand washing. Problems from filamentous green algae were minimized by optimizing the run-length at critical times of the year. For most water quality determinants, there were few problems in uprating from approximately 20 cm/hr to 40 cm/hr. The most serious problem was in the break-through of Escherichia coli in very cold water conditions. With appropriate attention to the reliability of the disinfection process, under these conditions, the problem is manageable. (See also W90-08470) (Geiger-PTT)
W90-08472

SLOW SAND FILTRATION IN THE UNITED STATES.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
G. Logsdon, and K. Fox.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 29-45. 5 tab, 21 ref.

Descriptors: *Aquatic bacteria, *Filtration, *Giardia, *Sand filters, *Slow sand filtration, *Water treatment, Coagulation, Comparison studies, Disinfection, Performance evaluation, Surface water, Turbidity, Water quality.

Interest in slow sand filtration has increased dramatically in the United States in the past ten years. Research conducted to evaluate removal of Giardia cysts and bacteria, showed that slow sand filtration is very effective in removal of these contaminants. Slow sand filters are much simpler and easier to operate than plants that employ coagulation and rapid filtration. Slow sand filters are very well suited for treatment of low-turbidity, unfiltered surface waters and would be ideal for small utilities serving from 25 to 3000 persons. The U.S. EPA estimates that about 1000 slow sand filters may be built as a result of proposed EPA regulations on surface water treatment. (See also W90-08470) (Author's abstract)
W90-08473

IMPROVEMENT OF SLOW SAND FILTRATION: APPLICATION TO THE IVRY REHABILITATION PROJECT.
Societe Anonyme de Gestion des Eaux de Paris (France).
A. Montiel, B. Welte, and J. M. Barbier.
IN: Slow Sand Filtration: Recent Developments in

Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 47-89. 5 fig, 12 tab, 27 ref.

Descriptors: *Filtration, *Sand filters, *Slow sand filtration, *Water treatment, *Water treatment facilities, Activated carbon, Algae, Aquatic bacteria, Biofiltration, Chlorination, Coagulation, Disinfection, Drinking water, France, Ozonation, Phosphorus removal, Pretreatment of water, Turbidity, Water quality.

Slow sand filtration was implemented in Paris and other major European cities in the 17th, 18th, and 19th centuries to remove contaminants from surface waters to produce drinking water. Slow sand filtration was gradually abandoned between 1960 and 1975, but has since come back into use. Slow sand filtration consists in percolating water through a filtering medium composed of a 0.6 to 1 meter thick sand bed. After a few days, a complex biocenosis composed of algae, bacteria and zooplankton develops in the top layer of the filtering media. This biofiltration process must clarify the water and remove organic and mineral micropollutants as well as microorganisms contained in the water to be treated. The disadvantages of biofiltration are: difficulty in removing certain mineral micropollutants requiring an emergency reagent, and excessive proliferation of algae in the summer. The filtration process may be improved by introducing a clarification pretreatment process before filtration. Turbidity may be kept low by storage of raw water for more than fifteen days, microstraining, or coagulation on a filter or flocculation and sedimentation. The slow sand filtration plant at Ivry, a plant which meets 15% of the water needs for the city of Paris was improved by a 10 mg/L ferric chloride dosing upstream to reduce turbidity. Elimination of turbidity was also accompanied by improved removal of organic matter and phosphates. Slow sand filtration at the Ivry plant is conducted at a rate of 5 to 10 m/day followed by ozonization. (See also W90-08470) (Geiger-PTT)
W90-08474

MANAGEMENT OF SLOW SAND FILTERS IN RESPECT TO GROUND WATER QUALITY.
Institut fuer Wasserforschung, Schwerte (Germany, F.R.).
H. Sommer.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 91-101. 8 fig, 2 ref.

Descriptors: *Artificial recharge, *Filtration, *Groundwater management, *Groundwater quality, *Sand filters, *Slow sand filtration, *Water treatment, Drinking water, Groundwater recharge, Hydraulic gradient, Model studies, Pretreatment of water, Water quality, West Germany.

The Hengsen catchment area of West Germany utilizes artificial groundwater recharge. An optimization model controls the infiltration rates to the slow sand filters with respect to different boundary conditions. This management concept improves groundwater quality. Utilization of natural cleaning processes during underground passage of groundwater and an optimal mixing of different groundwater types can be influenced by control of hydraulic gradients. The control of infiltration and discharge rates can reduce the concentrations of undesirable substances in the catchment area. The optimization model was successfully applied to reduce iron and manganese concentrations in the drain tile. In the future a nonlinear optimization model will be developed to reduce the concentration of organic compounds. In some cases the optimization concept should be considered as a low cost alternative to technological approaches. (See also W90-08470) (Geiger-PTT)
W90-08475

ROUGHING GRAVEL FILTERS FOR SUSPENDED SOLIDS REMOVAL.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).

Group 5F—Water Treatment and Quality Alteration

M. Wegelin.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 103-122. 12 fig, 4 tab, 16 ref.

Descriptors: *Filtration, *Pretreatment of water, *Sand filters, *Slow sand filtration, *Suspended solids, *Turbidity, Chemical treatment, Developing countries, Drinking water, Gravel, Gravel filters, Rural areas, Water treatment.

Reasonable operation of slow sand filters is only possible with raw water of low turbidity. Therefore, pretreatment of the generally turbid surface water is usually required. Prefiltration is an adequate process applied in the past but now is often replaced by chemical water treatment techniques. However, roughing gravel filters recently received considerable attention because of their simple design and reliable operation. Raw water characteristics, local physical conditions and available resources will determine the most appropriate prefilter type. Comparative field tests are planned to develop selection criteria. Prefilters and slow sand filters present a potential treatment combination which will be gaining increasing importance in rural water treatment technology. Size of filter material and rate of filtration are two possible criteria for filter classification. Rapid and slow sand filters differ from intake and roughing filters by their smaller filter material size. On account of the coarse filter material and the low filtration rate applied in roughing filtration, filter resistance hardly increases during filter operation. Mechanical equipment is not required for flow control or filter cleaning. The roughing filters have a considerable silt storage capacity and, consequently, filter cleaning is required at intervals of weeks to months. Intake and dynamic filters located directly in the river or canal improve the water quality at the point of abstraction. The roughing gravel filters require separate watertight structures. The flow direction in roughing filters can either be vertical as is the case for downflow and upflow filters, or horizontal as in the horizontal-flow roughing filters. Extensive field testing is being conducted at the Asian Institute of Technology in Bangkok, the University of Dar es Salaam in Tanzania, and the International Reference Center for Waste Disposal in Switzerland. (See also W90-08470) (Geiger-PTT)
W90-08476

UPFLOW COARSE-GRAINED PREFILTER FOR SLOW SAND FILTRATION.
Sao Paulo Univ., Sao Carlos (Brazil). Dept. de Hidraulica e Saneamento.
L. Di Bernardo.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 123-140. 9 fig, 2 tab, 8 ref.

Descriptors: *Filtration, *Gravel, *Pretreatment of water, *Sand filters, *Slow sand filtration, *Water treatment, Brazil, Coliforms, Color, Iron, Pilot plants, Turbidity.

Two pilot plants in Brazil, one consisting of a single unit with coarse sand supported on a gravel layer (CSP) and the other of a single unit with four gravel sublayers (GP) were compared for their ability to improve raw water quality before water treatment operations. The filters were operated in parallel using filtration rates varying from 4 to 36 meters/day. Since the plant start-up, effluents with better quality than the influent were produced in the CSP and the GP units with significant reduction of turbidity, apparent color and iron and manganese concentrations. Attenuation capacity of both units due to occurrence of influent water quality peaks was very low. The higher the influent water peak of turbidity, apparent color and iron and manganese, the higher the effluent peaks in the CSP and the GP. Approach velocities in the range of 12 and 36 meters/day appeared to influence very little the quality of effluents produced in the CSP and GP units. A better effluent quality was produced in the CSP than in the GP unit. Intermediate drainages in the CSP increased the run length because of head loss recovery, but

caused detrimental effects mainly on the bacteriological quality of the effluent. For the GP, intermediate drainage caused a substantial removal of solids observed in the discharged water and resulted in a negligible variation in head loss, but a serious detrimental effect in bacteriological effluent quality occurred with a high increase of total coliform after the plant was put in service. (See also W90-08470) (Geiger-PTT)
W90-08477

PRETREATMENT WITH PEBBLE MATRIX FILTRATION.
University Coll., London (England). Dept. of Civil and Municipal Engineering.
K. J. Ives, and J. P. Rajapakse.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 141-152. 11 fig, 1 tab, 3 ref.

Descriptors: *Filtration, *Pretreatment of water, *Sand filters, *Slow sand filtration, *Water treatment, Cleaning, Developing countries, Suspended solids, Turbidity.

Pebble matrix filtration reduces suspended solid concentrations in highly turbid waters from values up to 5000 mg/L to below 25 mg/L. This protects slow sand filters from excessive clogging by monsoon river waters. The pebble matrix filter consists of a deep layer of pebbles, approximately 50 mm in size, infilled in its lower part by sand usually less than 1 mm in size. Runs of about 20 hr to head losses not exceeding 1.5 m, have been achieved with a flow rate of 0.72 m/hr. Cleaning is simply achieved with 2 drainage cycles followed by backwashing with raw water only. The pebble matrix filter is recommended as an appropriate pretreatment method for slow sand filtration under semi-rural conditions in developing countries where monsoon turbidities reach several thousand mg/L. (See also W90-08470) (Author's abstract)
W90-08478

OZONATION AND SLOW SAND FILTRATION FOR THE TREATMENT OF COLOURED UPLAND WATERS: PILOT PLANT INVESTIGATIONS.
Ozotech Ltd., Burgess Hill (England).
G. F. Greaves, P. G. Grundy, and G. S. Taylor.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 153-162. 3 fig, 1 ref.

Descriptors: *Color removal, *Filtration, *Ozonation, *Pretreatment of water, *Sand filters, *Slow sand filtration, England, Hydrogen ion concentration, Iron, Manganese, Pilot plants, Turbidity, Water quality, Water treatment.

North West Water Authority has substantial assets at their Llanforda Waterworks, Oswestry, which include land, civil structures associated with slow sand filters, and a mechanical plant. In order to comply with E.C. legislation, final water color needs to be reduced. The use of coagulants is inappropriate and pre-ozonation is being investigated as a viable alternative. Pilot plant work has indicated satisfactory color removal, although ozonation did not seem to enhance turbidity removal in the filters. Pre-ozonation improved the average iron removal, but had no effect on the removal of manganese. Ozonation followed by filtration resulted in a marginally higher filtrate pH of 6.9-7.1. Filter head loss develops progressively after pre-ozonation and not exponentially towards the end of the run as in the control filter without pre-ozonation. At Oswestry this led to extended filter runs through the winter and spring period. (See also W90-08470) (Geiger-PTT)
W90-08479

ECOLOGY OF SLOW SAND FILTERS.
Royal Holloway and Bedford New Coll., Egham (England). Dept. of Biology.
A. Duncan.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and

Sons, New York, New York. 1988. p 163-180. 8 fig, 1 tab, 34 ref.

Descriptors: *Filtration, *Population dynamics, *Sand filters, *Slow sand filtration, *Water treatment, Aquatic bacteria, Biomass, Chlorophyll a, Ecology, Microorganisms, Oligochaetes, Organic carbon, Organic matter, Particulate matter, Protozoa, Species composition.

Changes in the abundance and vertical distribution of the interstitial sand fauna and flora (ciliates, worms, bacteria and chlorophyll a) as well as the sand particulate organic matter is described throughout a run of an operational slow sand filter bed and is related to its head loss and input carbon loading. The interstitial sand protozoans, which number thousands of cells per cu cm, consist of flagellates, ciliates and amoebas. The rest of the fauna consist of metazoan groups of animals which are capable of inhabiting the sand interstices because of their small sizes. The use of a core sampler permitted the retrieval of sand samples from different depths during the course of a filter run. During a filter run at the Hampton Works which lasted from January to March 1976, substantial worm (Enchytraeus buchholzi) populations did not develop until day 23 of the run when the surface particulate organic carbon (POC) content was about 1 mg C/cu cm and in the sand below 2-3 cm much lower values. By day 23 and more markedly by days 37 and 51, the worms were avoiding the surface high concentrations of POC and were establishing peak densities in the depths below. Filter runs studying the distribution of ciliates showed that algal-feeding Chilodonella and the omnivorous spirotrichs are the main contributors to the ciliate biomass peak that developed at 3 cm depth on day 5. By day 12, the main ciliate biomass occupied the upper 5 cm of sand and consisted of bacteriovores such as the filtering holotrichs and peritrichs together with substantial biomasses of omnivores, herbivores and carnivores. By day 20, the main ciliate biomass had shifted down to 5 and 10 cm depth and consisted of herbivores, omnivores and carnivores. Development of the populations of animals inhabiting the slow sand filter beds of Hampton were shown to be linked with the changes occurring within the beds, as measured by head loss and vertical flow rate. The living biomasses of bacteria, algae and protozoans increased at a faster rate at head losses up to 0.64 m and slowed down at higher head losses, reflecting the food supply situation. (See also W90-08470) (Geiger-PTT)
W90-08480

SOME ASPECTS OF THE FILTRATION OF WATER CONTAINING CENTRIC DIATOMS.
University of East Anglia, Norwich (England). School of Environmental Sciences.
K. B. Clarke.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 181-190. 4 fig, 12 ref.

Descriptors: *Diatoms, *Filtration, *Sand filters, *Slow sand filtration, *Water treatment, Algae, Cyclotella, Maintenance, Microorganisms.

Rapid filters are relatively ineffective against fibrilate centric diatoms. The washing of the beds seems to render the filters permeable to these organisms. Slow sand filters, if mature, can cope with a considerable load of fibrilate centric diatoms quite well. Slow sand filters which have just been cleaned seal quickly and in doing so allow the diatoms to enter the bed in greater numbers than mature beds. While fibrilate centric diatoms penetrated the rapid filters with ease, they did not penetrate slow sand filters in any significant numbers even when the supernatant water contained over 200 thousand cells/ml of one of the smallest species. Green filters that are usually caused by algae can also be caused by centric diatoms. The practice of back-filling beds from below may be a contributory cause of green filters by diatoms. In a green filter that occurred during slow sand filtration at the Lound Works of the East Anglian Water Company, a chytrid infection cleared the

green filter. Numbers of Cyclotella penetrating the bed completely were very small (4-22 cells/ml). (Geiger-PTT)
W90-08481

DEVELOPMENT OF A SLOW SAND FILTER MODEL AS A BIOASSAY.
Institut fuer Wasserforschung, Dortmund (Germany, F.R.).
For primary bibliographic entry see Field 4B.
W90-08482

REMOVAL OF VIRUSES BY FILTRATION THROUGH SAND.
Robens Inst. of Industrial and Environmental Health and Safety, Guildford (England).
D. Wheeler, J. Bartram, and B. J. Lloyd.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 207-229. 11 fig, 4 tab, 29 ref.

Descriptors: *Developing countries, *Disinfection, *Filtration, *Sand filters, *Slow sand filtration, *Viruses, *Water treatment, Adsorption, Bacteria, Bioindicators, Biological wastewater treatment, Coliforms, Enteroviruses, Rotaviruses, Separation techniques.

The effect of related biological factors on the efficiency of virus removal during filtration through sand was examined in a series of three experiments. The first experiment compared the removal of indicator bacteria and viruses through a small scale protected slow sand filtration system designed for use in less developed countries. The second experiment examined the removal of indigenous rotavirus through sand and anaerobic biomass beneath a wastewater lagoon and irrigation site in Peru. The third experiment studied the adsorption and attenuation of simian rotavirus SA11 with various substrates extracted from both protected and conventional slow sand filters. Results from the first experiment showed that the pattern of removal of viruses was similar to that obtained for other microorganisms of hygienic significance. In the second experiment it was shown that an anaerobic microbial sludge overlying sand in a wastewater lagoon achieves much greater elimination of indigenous rotavirus than a similar environment where no biomass is deposited (i.e, below irrigation channels). Preliminary results from laboratory adsorption experiments (third experiment) also confirmed the importance of biomass in enhancing the removal of rotavirus from the aqueous phase. More work on the attenuation of viruses in sand filtration is being conducted at the University of Surrey. If it can be shown that the removal of agents with low infective doses (eg. enteric viruses) by slow sand filtration is as reliable as the customary removal of indicator bacteria, then the process could be of considerable benefit in reducing the waterborne transmission of disease in developing countries. (See also W90-08470) (Geiger-PTT)
W90-08483

EFFECTS OF HIGH-CARBON AND HIGH-COLIFORM FEED WATERS ON THE PERFORMANCE OF SLOW SAND FILTERS UNDER TROPICAL CONDITIONS.
Colorado Univ., Boulder. Dept. of Civil and Environmental Engineering.
J. M. Barrett, and J. Silverstein.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 231-252. 8 fig, 2 tab, 15 ref.

Descriptors: *Coliforms, *Filtration, *Organic carbon, *Sand filters, *Slow sand filtration, *Tropical regions, Biofilms, Color, Head loss, Humic substances, Hydraulic conductivity, Hydrogen ion concentration, Organic matter, Performance evaluation, Pilot plants, Turbidity, Water treatment.

Pilot-scale slow sand filters, operated at a temperature of 25 C, were fed source waters characteristic of both unpolluted and polluted surface supplies. Under non-polluted conditions, that is, when

source waters contained only 1 ppm carbon, coliform removals exceeded 99%, and run times were greater than three weeks. However, when influent carbon concentrations were greater than 1 ppm, filter run times were short, five days or less, due to a rapid increase in head loss. The head loss resulted from biofilm growth in the first few centimeters of the sand bed. Given an influent bacterial concentration of approximately 10,000 cells per ml, coliform removals were inadequate during the short run times. Removal of labile total organic carbon (TOC) reached a maximum of 80% in two days. When humic compounds comprised 50% of the influent TOC, maximum carbon removals averaged 57%. These results indicated that slow sand filtration facilities built to conventional specifications are not adequate when the source water to be treated is high in dissolved organic carbon and coliform bacteria. (See also W90-08470) (Geiger-PTT)
W90-08484

BENEFITS OF COVERED SLOW SAND FILTRATION.
Municipal Water Works of Amsterdam, Heemstede (Netherlands). Water Quality Dept.
J. A. Schellart.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 253-264. 3 fig, 5 tab, 5 ref.

Descriptors: *Drinking water, *Filter covers, *Filtration, *Sand filters, *Slow sand filtration, *Water treatment, Algae, Coliforms, Construction costs, Disinfection, Fertilization, Operating costs, Organic carbon, Pathogens, Water quality.

The Municipal Water Works of Amsterdam prepares drinking water at two production plants with covered slow sand filtration as the final purification step. In the past the slow sand filters were not covered and filter runs were much shorter than today. The uncovered filters experienced more problems with process operation and quality of the finished drinking water. The covered slow sand filters experienced no fecal contamination by birds and thus no introduction of coliforms, pathogenic microorganisms, fertilizing nitrogen and phosphorus compounds. Lack of sunlight in the covered filters allowed no growth of algae biomass and resulted in lower levels of organics in the filtrate, lower biological regrowth potential and fewer taste problems in the finished drinking water. The covered filters required less cleaning and showed no increase of pH by photosynthesis on the filter surfaces and thus no increase of resistance by biogenic softening. The covered filters had no frozen filter surface during hard frost periods in severe winters and thus had higher capacity throughout the year. With the higher filtration rates possible in the covered filters, lower filtration areas are required lowering building expenses. The covered filters maintained a rather constant and high oxygen concentration in the filtrate and showed no differences in O2 concentration between day and night in summer and they offered a stable microbiological drinking water quality dependent only on water temperature. The covered sand filters lowered or negated the need for final disinfection, lowered consumption of chlorine, and decreased expenses for disinfection. (See also W90-08470) (Geiger-PTT)
W90-08485

COMPARISONS BETWEEN ACTIVATED CARBON AND SLOW SAND FILTRATION IN THE TREATMENT OF SURFACE WATERS.
Lyonnaise des Eaux, Le Pecq (France). Lab. Central.
J. Mallevialle, and J. P. Duguet.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 265-280. 12 fig, 6 tab, 6 ref.

Descriptors: *Activated carbon, *Carbon filters, *Filtration, *Sand filters, *Slow sand filtration, *Water treatment, Biodegradation, Coagulation, Comparison studies, Drinking water, Flocculation, France, Organic matter, Sedimentation, Surface water.

The water purifying efficiency of a two-step system at the Mont Valerien plant serving the city of Paris on the Seine River was investigated. The first process was a physicochemical process with coagulation, flocculation and sedimentation, followed by rapid sand filtration. The second process was slow sand filtration. Different types of carbon were evaluated and different filtration velocities in the second filtration stage were tested. The use of very slow filtration velocities and comparison with higher rates made it possible to study the mechanism of removal of organic matter. Slow sand filters treating clarified water in the second stage removed an average of 10% total organic carbon (TOC) primarily through biodegradation. Slow granular activated carbon (GAC) filters removed an additional 15% TOC primarily through adsorption to yield a total reduction of 25%. Ozone removed 5% but did not enhance GAC performance. Rapid GAC filters removed at least 10% more TOC than the slow ones. The total reduction with the best carbon reached an average of 40% for the whole year of the experiment. Biodegradation did not seem to be significantly higher in GAC than in sand. (See also W90-08470) (Geiger-PTT)
W90-08486

MODIFICATIONS TO THE SLOW RATE FILTRATION PROCESS FOR IMPROVED TRIHALOMETHANE PRECURSOR REMOVAL.
New Hampshire Univ., Durham. Dept. of Civil Engineering.
M. R. Collins, and T. T. Eighmy.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 281-304. 16 fig, 6 tab, 53 ref.

Descriptors: *Activated carbon, *Filtration, *Sand filters, *Slow sand filtration, *Trihalomethanes, *Water treatment, Adsorption, Comparison studies, Cost analysis, Microbial degradation, Organic matter.

The ability of the slow rate filtration process to remove trihalomethane precursor material was evaluated at slow sand filter facilities at Springfield, Massachusetts and West Hartford and New Haven, Connecticut. Two sets of untreated and treated water samples and filter media core samples from the three municipal slow sand filtration plants were acquired and completely analyzed during 1987. Pilot-scale studies were also conducted on a surface water supply for the City of Portsmouth, New Hampshire, and on a surface water supply for the town of Ashland, New Hampshire. West Hartford filters consistently achieved higher precursor removals despite having the highest loading rates and shortest media contact times. By harrowing the schmutzdecke into the filter media, much higher cell concentrations over the entire filter depth were observed. This filter cleaning method enhanced dissolved organic carbon, UV absorbance, and trihalomethane formation potential mass removal rates at this facility. Pilot-scale microbial population distributions were similar to municipal filters. The anionic resin and granular activated carbon (GAC) amended filters consistently achieved higher organic precursor removals than any other filter media combination studied. Organic precursor removals in slow rate filtration was a function of both the microbiological maturity and adsorptive capacity of the schmutzdecke and filter bed. Organic precursor removals were not significantly dependent on the filter loading rates in this study. Particulate removals by slow sand filters appeared to be independent of typical loading rates but continued to improve as the filters matured during the filtration run. The anionic resin amended slow rate filter consistently achieved higher removals of trihalomethane precursor material than the slow sand filters operating at different loading rates or the alum-based conventional treatment process throughout the entire study run. Where land area requirements are not a concern, the most cost effective precursor treatment scheme to construct for small communities is the GAC amended slow sand filter followed closely by the anionic resin amended filter and a pack-

aged treatment plant. (See also W90-08470) (Geiger-PTT)
W90-08487

PILOT PLANT EVALUATION OF FABRIC-PROTECTED SLOW SAND FILTERS.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
T. S. A. Mbwette, and N. J. D. Graham.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 305-329. 8 fig, 5 tab 57 ref.

Descriptors: *Fabrics, *Filtration, *Sand filters, *Slow sand filtration, *Water treatment, Comparison studies, Head loss, Performance evaluation, Pilot plants.

Use of non-woven synthetic fabric (NWF) with slow sand filtration offers many benefits over conventional slow sand filtration. Recent pilot plant studies at the Thames Water Ashford Common Treatment Works showed that application of an optimal thickness and type of NWF as a surface matting can dramatically increase slow sand filtration run times by a factor of four or more. Particle deposition and biological accumulation can be contained within the fabric, thereby avoiding head loss development within the underlying sand. The correct selection of thickness, type and configuration (if more than one fabric) of NWF matting is crucial to avoiding solids penetration into the sand and maximizing filter run times. Experience suggests that calendered or thermic bonded NWF are not suitable in this application. In general, the overall physical and biological treatment performance of conventional slow sand filtration is very high so that application of NWF matting appears to make a negligible improvement to this. (See also W90-08470) (Geiger-PTT)
W90-08488

ADVANCED TECHNIQUES FOR UPGRADING LARGE SCALE SLOW SAND FILTERS.
Thames Polytechnic, London (England).
A. J. Rachwal, M. J. Bauer, and J. T. West.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 331-347. 3 fig, 4 tab, 12 ref.

Descriptors: *Filtration, *Sand filters, *Slow sand filtration, *Upgrading, *Water treatment, Algae, Automation, Cleaning, Computers, Filter covers, Organic matter, Ozonation, Ozone.

Thames Water operates eight slow sand filtration plants in London treating reservoir stored lowland river water. A major program of uprating and modernization of the largest plants is in progress. Research at full scale showed that average filtration rates of 0.3 m/hr with peaks in excess of 0.4 m/hr were sustainable with advanced filter management techniques. Filter downtime for cleaning and resanding was shown to be a key output limiting factor. A novel underwater sand skimming method has been developed aided by a laser guidance system and computer control. Work on shading of filters with floating covers to reduce in bed algal growth is underway. Pilot and full scale studies on the use of ozone with slow sand filtration showed improved filter performance and increased organics removal. Pre-ozonated primary filters, fabric replacement of sand, and granular activated carbon are also being studied as part of current slow sand filtration research. (See also W90-08470) (Geiger-PTT)
W90-08489

DEVELOPMENTS IN MODELLING SLOW SAND FILTRATION.
Thames Polytechnic, London (England).
C. A. Woodward, and C. T. Ta.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 349-366. 11 fig, 3 tab, 11 ref.

Descriptors: *Filtration, *Mathematical models, *Model studies, *Sand filters, *Slow sand filtra-

tion, *Water treatment, Flow rates, Head loss, Mathematical studies, Microcomputers.

A mathematical model for the hydraulic behavior of a slow sand filter has been developed. For a single filter, the model predicts the flow rates for given head loss data within 15% of the observed values. This model has been incorporated in a FORTRAN computer program (SANNET) to study the slow sand filter network at Ashford Common Water Treatment Works. From the total output of the network, the flow rates and head losses for all filters can be estimated within 5 megaliters/day and 0.2 m respectively. A microcomputer version of SANNET running on 20 MHz 80386 processor requires less than 15 seconds for each forecast. The program will form the heart of a Filter Bed Management system, to be implemented at three or more of the Authorities' works in the near future. (See also W90-08470) (Geiger-PTT)
W90-08490

APPLICATION OF POLYURETHANE TO IMPROVE SLOW SAND FILTERS.
Ghent Rijksuniversiteit (Belgium). Lab. for Microbial Ecology.
P. Vochten, J. Liessens, and W. Verstraete.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 367-378. 10 fig, 4 tab, 11 ref.

Descriptors: *Filtration, *Plastics, *Prefiltration, *Sand filters, *Slow sand filtration, *Water treatment, Aeration, Ammonium, Biochemical oxygen demand, Clogging, Coliforms, Head loss, Organic matter, Pilot plants, Polymers, Subsurface filters, Water quality.

The potential use of reticulated polyurethane prefilters in slow sand filtration was studied on a small pilot-scale. Two alternative types of prefilters were studied. In the first type, a 10 cm layer of highly porous polyurethane foam was installed on top of the filter bed. By this modification, the biological activity was distributed across the prefilter surface, creating a kind of expanded Schmutzdecke. This resulted in a significant increase in oxygen consumption over the filter indicating an increased microbial activity. The installation of the polyurethane matrix prevented clogging and decreased the head loss across the sand filter resulting in longer filtration cycles. In a second modification, a 75 cm prefilter of polyurethane was aerated at the bottom. This submerged aerated matrix, with high microbial activity, enhanced the slow sand filter performance especially for low quality water containing substantial amounts of NH4(+) and biodegradable organic matter. The removal of BOD and NOD (NOD = 4.33 x ammonia-N) over the filter was significantly better compared to the reference filter. A better bacteriological quality of the filtrate was observed with regard to the number of Escherichia coli and Streptococcus faecalis. The aerated prefilter also prolonged the length of filter runs in a substantial way. (See also W90-08470) (Author's abstract)
W90-08491

DUAL MEDIA FILTRATION FOR THE REHABILITATION OF AN EXISTING SLOW SAND FILTER IN ZIMBABWE.
T. F. Ryan.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 379-392. 5 fig, 1 tab, 3 ref.

Descriptors: *Filtration, *Grain size, *Sand filters, *Slow sand filtration, *Water treatment, *Zimbabwe, Algae, Coliforms, Cost analysis, Developing countries, Head loss, Maintenance, Performance evaluation, Turbidity.

Studies were carried out to improve the performance of an existing slow sand filter unit at the Howard Institute in Zimbabwe which suffered from extremely short filter runs. Investigations showed the main cause of the short runs was too small a sand grain size. Length of filter run could

be substantially increased by replacing the existing sand by a coarser sand but at considerable cost. The solution proposed was a dual media filter whereby the existing fine sand was superimposed by a layer of coarser sand. This had the benefits of improved filter run, efficient coliform removal and, importantly, low cost implementation. (See also W90-08470) (Author's abstract)
W90-08492

PERFORMANCE OF SLOW SAND FILTERS IN PERU.
Robens Inst. of Industrial and Environmental Health and Safety, Guildford (England).
B. Lloyd, M. Pardon, and D. Wheeler.
IN: Slow Sand Filtration: Recent Developments in Water Treatment Technology. John Wiley and Sons, New York, New York. 1988. p 393-411. 5 fig, 6 tab, 6 ref.

Descriptors: *Filtration, *Peru, *Rural areas, *Sand filters, *Slow sand filtration, *Water treatment, Chlorination, Coliforms, Disinfection, Gravel, Operating policies, Performance evaluation, Prefiltration, Turbidity, Water quality.

After 25 yr experience of construction of rural water treatment systems in Peru recent diagnostic surveillance studies demonstrated that slow sand filtration plants have uniformly failed to reduce contamination of surface water sources to provide a safe water supply. Reasons for the failure of slow sand filters include administrative problems of operation and maintenance, technical problems of faulty construction, problems with flow rate control at the point of abstraction, short circuiting of settlers and sedimenters through inadequate capacity and lack of baffling. In addition the slow sand filters were unable to cope with high turbidities and flow variation. Diagnostic surveys showed that slow sand filter performance could be enhanced with gravel prefiltration and protected slow sand filters. Sedimentation and prefiltration together produced a 71.6% reduction in fecal coliform counts in filtrates of slow sand filters at Azpitia compared with a 94% reduction at Cocharcas. Pot chlorinators were installed after the sand filters at both these rehabilitated rural treatment plants to remove the remaining fecal coliform contamination and to achieve class A water quality. (See also W90-08470) (Geiger-PTT)
W90-08493

WATER, WASTEWATER, AND SLUDGE FILTRATION.
For primary bibliographic entry see Field 5D.
W90-08494

OVERVIEW OF DEEP BED FILTRATION: DIFFERENT TYPES AND MATHEMATICAL MODELS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran, and R. B. Aim.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 1-16. 4 fig, 5 tab, 53 ref.

Descriptors: *Deep bed filtration, *Filtration, *Mathematical models, *Model studies, *Sand filters, *Water treatment, Backwash, Design criteria, Filter media, Head loss, Optimization, Separation techniques, Wastewater treatment.

Filtration technologies are classified under two major categories, depending mainly on the mode of filtration: slow sand filtration and rapid sand filtration. In conventional rapid filters, stratification of filter media occurs after the backwash. To overcome this, dual or multimedia filtration, or coarse size, narrowly graded media filtration have been proposed. High-rate filtration and declining-rate filtration are advantageous in most cases. Direct filtration eliminates some operations from conventional water treatment thus saving money. Backwashing one filter with the flow of other filters also saves on operating expenses. Optimization of filter design occurs when the filter reaches its head loss limit at the same time that the filtrate

quality deteriorates to an unacceptable value. Numerous mathematical models have been proposed to explain filtration behavior at various stages. A mathematical model based on material balance and kinetic equations evaluates filter performance by filtrate quality. Other mathematical models describe filter performance in terms of head loss through a clean bed or through a clogged bed. (See also W90-08494) (Geiger-PTT)
W90-08495

THEORETICAL APPROACH TO DEEP BED FILTRATION.
Gesamthochschule Duisburg (Germany, F.R.). Inst. of Water Technology.
For primary bibliographic entry see Field 5D.
W90-08496

DIRECT FILTRATION.
Culligan Italiana S.p.A., Bologna (Italy).
L. Coccagna.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 57-75. 11 fig, 7 tab, 35 ref.

Descriptors: *Disinfection, *Filtration, *Tertiary wastewater treatment, *Wastewater treatment, *Water treatment, Algae, Arsenic, Clarification, Coagulation, Cost analysis, Design criteria, Odor control, Phosphorus removal, Raw water, Suspended solids, Turbidity.

Direct filtration has been used throughout history to provide the clearest water possible for drinking water. Direct filtration can also be employed for the removal of dissolved substances. To prevent microbic growths in the filters and the formation of mud-balls, it is necessary to keep the filtering bed disinfected. It is desirable to use agents that limit the formation of organic precursors during disinfection. pH adjustments are necessary both before and after filtration to limit the corrosiveness of water, optimize the removal of humic acids and iron, and optimize the use of coagulants. Aluminum, iron sulfates and chlorides are commonly employed as metal coagulants. Polyelectrolytes or other substances may be used as filtration aids. Filters used in water treatment are single-layer sand filters, or dual or multi-media filters by design. The feasibility of applying direct filtration rests on the concentration of suspended solids, the possibility of varying the dosage of chemicals according to variations in turbidity of raw water, low filtration velocities, and cycle continuity. The omnifiltration system (OFSY) provides series of identical multimedia filters making it possible to employ raw water for washing operations, thus saving treated water. In-series direct filtration is successful in removing turbidity, algae, and color. The OFSY system is useful in the clarification of effluents from biological treatment units of sewage water as well as the upgraded removal of phosphorus from sewage water. The OFSY system has proven useful in removing arsenic from raw waters while removing other pollutants. The OFSY system has reduced costs compared to conventional treatment in regard to investment cost, space taken up by installation, and chemical treatment. (See also W90-08494) (Geiger-PTT)
W90-08497

MICROSTRAINING.
Beaudrey (E.) and Cie, Paris (France).
For primary bibliographic entry see Field 5D.
W90-08499

PRECOAT FILTRATION.
Manville de France, St.-Cloud.
R. Illner.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 117-128. 5 fig, 3 tab, 1 ref.

Descriptors: *Filtration, *Pretreatment of water, *Suspended solids, *Wastewater treatment, *Water treatment, Algae, Color removal, Cost analysis, Design criteria, Drinking water, Filters, Odor control, Pressure filtration, Raw water, Separation techniques, Taste.

Pressure filtration using filter aids is a three-step operation, namely: precoating, body feed, and washing. A rotary vacuum precoat filter consists of a horizontal drum, 30 to 50% of which is submerged in a filter bowl containing the water to be filtered. This drum is covered with a clean septum in order to build up a precoat. Filtration efficiency depends upon several factors, such as filter aid grade; drum submergence, drum speed; knife advance rate; vacuum; filter cloth (type, opening); knife sharpness; and concentration of the filter aid slurry. Diatomaceous earth and perlite are commonly used filter aids. Precoat filters operate by physically straining solids out of the water. Where the raw water source and other conditions are suitable, precoat filtration can offer a number of economic benefits to the end user. Swimming pools equipped with diatomite filters may not require as much chlorine as pools equipped with other types of filters. A rotary vacuum precoat filter is preferred for wastewater pretreatment, since the build-up of a precoat is well known in this case. Many surface-water supplies, such as lakes or ponds, may have algae, color, or taste-and-odor problems that would require additional treatment in conjunction with precoat filtration. The use of a microstrainer prior to the precoat filter has been found to be effective in removing microscopic material, including plankton and amorphous matter. Activated carbon is used prior to precoat filtration to remove soluble iron and manganese. Precoat filtration is also effective in removing such agents as asbestos or giardia cysts to obtain high quality drinking water. (See also W90-08494) (Geiger-PTT)
W90-08500

CARTRIDGE FILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran.
IN: Water, Wastewater, and Sludge Filtration. CRC Press, Inc., Boca Raton, Florida. 1989. p 129-138. 6 fig, 3 ref.

Descriptors: *Filters, *Filtration, *Water treatment, Distilled water, Pretreatment of water, Separation techniques.

Cartridge filters are used when particulate loads in fluids are low (e.g., 0.01%). Cartridge filters can clarify fluids to an optically clear stage and they are often used in the sterilization of liquids. Cartridge filters are classified on the basis of the mechanism of removal as surface and depth types. In surface type filters, the medium acts as a sieve, trapping solids on its surface only. Depth type filters tend to trap particles within the interstices of their internal structure. The filtration properties of a cartridge filter depend upon its differential pressure vs. flow rate characteristics, the efficiency of the particle removal, and the dirt-holding capacity. The design of the cartridge depends on the quality of filtrate desired, correct filter medium selection, maximum available pressure drop, the scale-up to full scale from laboratory scale, and the pretreatment to be used. Filter cartridges are broadly classified into two types: disposable cartridges and cleanable cartridges. Cartridge filters are used to purify water for use in the pharmaceutical industry, to decolorize liquids and gases, to produce distilled water, or as a pretreatment to reverse osmosis in the production of ultrapure water. (See also W90-08494) (Geiger-PTT)
W90-08501

REVERSE OSMOSIS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W90-08502

MICROFILTRATION.
Enka A.G., Wuppertal (Germany, F.R.).
For primary bibliographic entry see Field 5D.
W90-08504

ELECTRODIALYSIS.
Toulouse-3 Univ. (France). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W90-08505

VACUUM FILTRATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5E.
W90-08506

SIGNIFICANCE AND TREATMENT OF VOLATILE ORGANIC COMPOUNDS IN WATER SUPPLIES.
Lewis Publishers, Inc., Chelsea, Michigan. 1990. 558p. Edited by Neil M. Ram, Russell F. Christman, and Kenneth P. Cantor.

Descriptors: *Drinking water, *Path of pollutants, *Volatile organic compounds, *Water treatment, Adsorption, Aeration, Biological treatment, Chemical treatment, Costs, Economic aspects, Organic compounds, Pollutant identification, Solute transport.

Volatile organic compounds (VOCs) have a tendency to migrate or diffuse from water (aqueous phase) to air (gaseous phase) under normal environmental conditions. Within this broad understanding, this book brings together the important issues and technical challenges surrounding VOCs in drinking water. The book is organized into six general sections, which describe the background, methods, occurrence, fate and transport, treatment and costs, and risks of VOC contamination. Chapter 1 covers the statutory and regulatory basis for the control of chemicals in drinking water and the 1986 Amendments to the Safe Drinking Water Act (SDWA) as they affect VOCs in drinking water. Chapter 2 reviews: (1) the nature and extent of groundwater contamination, and (2) management controls, including administrative arrangements, and source, product, land use, and economic controls. Chapter 3 describes research methods for determination of aqueous VOCs, considering issues of sampling, broad spectrum analysis, and VOC partitioning from water. Chapter 4 reviews the EPA-approved analytical methods for VOC analysis in drinking water. Chapter 5 presents sampling and analysis procedures to minimize volatilization loss. Chapter 6 reviews past and present approaches of fiber optics to measure VOCs in groundwater, allowing real-time in situ measurements. Chapter 7 reviews the national surveys of VOCs in ground and surface waters: National Organics Reconnaissance, National Organics Monitoring, Community Water Supply, and Ground Water Supply surveys. Chapter 9 presents a conceptual overview of VOC transport in groundwater. Chapter 10 discusses the physical-chemical properties and fate of VOCs using the fugacity approach, which is an equilibrium criterion derived from the concept of chemical potential. Chapter 11 focuses on biologically mediated transformations that affect the fate of VOCs in the environment. Chapter 12 reviews the theory and applications of VOC removal from drinking water by adsorption and describes modeling of VOC adsorption onto granular activated carbon (GA). Chapter 13 presents a detailed model for a packed tower aeration (PTA) system. Chapter 14 describes oxidative treatment methods that convert VOCs to relatively harmless substances. Chapter 15 reviews unit process research, being conducted by EPA's Drinking Water Research Division. Chapter 16 describes point-of-use/point-of-entry systems technology used for industrial and drinking water treatment. Chapter 17 presents an economic analysis of GA and PTA using available models and field data. The remaining five chapters discuss the risks involved in water treatment for VOCs. (See W90-08510 thru W90-08531) (Lantz-PTT)
W90-08509

STATUTORY AND REGULATORY BASIS FOR CONTROL OF VOLATILE ORGANIC CHEMICALS IN DRINKING WATER.
Environmental Protection Agency, Washington, DC. Div. of Water Supply.
For primary bibliographic entry see Field 5G.

W90-08510

ANALYTICAL METHODS FOR VOLATILE ORGANIC COMPOUND DETERMINATION.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Quality Assessment Branch.
H. J. Brass.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 57-72, 1 fig, 2 tab, 35 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Drinking water, *Pollutant identification, *Volatile organic compounds, *Water analysis, Chemical extraction, Costs, Distillation, Laboratory methods, Monitoring, Organic compounds, Quality control, Quantitative analysis, Sample preservation.

The regulation of volatile organic chemicals (VOCs) in finished drinking waters in the United States is based, to a large extent, on their widespread occurrence and possible health significance. A narrow definition of VOCs, from an EPA regulatory standpoint is inclusive of those compounds that are amenable to determination by the purge and trap (P and T) procedure. They are of relatively high volatility and have low water solubility, so that they can be effectively sparged (or purged) from water. Although the immediate concern of the regulated community is focused on the VOCs described by P and T methodology, there are other procedures capable of qualitatively and, in some instances, quantitatively measuring VOCs as well as other low-molecular-weight compounds. Another technique is closed loop stripping, where very low levels (nanogm/L) of compounds, ranging from benzene to some PCB isomers, can be analyzed. Other techniques include headspace analysis, solid-phase extraction, micro and larger volume liquid-liquid extraction, continuous liquid-liquid extraction, and steam distillation. In this chapter, the following topics regarding the analysis of VOCs are discussed: the six available EPA methods; formal revisions to EPA methodology; defining the objectives of data gathering; quality assurance and quality control as applied to these methods; compound identification and limits of detection and quantitation; dechlorination and preservation; monitoring considerations; cost of analysis; and future analytical needs. (See also W90-08509) (Lantz-PTT)
W90-08513

NATIONAL SURVEYS OF VOLATILE ORGANIC COMPOUNDS IN GROUND AND SURFACE WATERS.
Environmental Protection Agency, Cincinnati, OH. Water Supply Technology Branch.
For primary bibliographic entry see Field 7B.
W90-08516

VOLATILE ORGANIC CHEMICALS AND INTENTIONAL WATER REUSE.
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-08517

REMOVAL OF VOLATILE ORGANIC COMPOUNDS FROM DRINKING WATER BY ADSORPTION.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
T. F. Speth.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 229-259, 12 fig, 3 tab, 133 ref.

Descriptors: *Adsorption, *Decision making, *Drinking water, *Volatile organic compounds, *Water treatment, Activated carbon, Carbon regeneration, Dioxins, Furans, Granular activated carbon, Organic compounds, Pretreatment of water, Water quality management, Water treatment facilities.

Designing granular activated carbon (GA) contactors for removing VOCs from groundwaters re-

quires a knowledge of the contaminants and their concentrations. The effects of adsorption competition, variable influence concentrations, preloading of natural dissolved organic matter, humic complexation with VOCs, and microbial growth should be considered. How the above effects are answered will lead to a decision whether to use granular activated carbon in a fixed bed or powdered activated carbon in the mixing basin. If powdered activated carbon is chosen, powdered-carbon jar tests should be completed to help verify performance. Any further improvement in performance must come from modifications of the treatment plant. If granular carbon is chosen, modeling is useful for preliminary costing and sizing, but pilot-scale columns should be used for final design. The final plant design should make optimal use of column configuration. Pretreatment processes must also be fully considered. Regeneration of activated carbon in a multiple hearth furnace or a fluidized-bed furnace has been shown to be a viable process. Research has shown that the capacity differences are negligible between virgin and regenerated carbon. For large utilities, on-site regeneration is a practical option. For smaller utilities, regional regeneration or disposal may be optimal. The 5-15% attrition of carbon during regeneration occurs mostly in the furnace and must be anticipated. Dioxins and furans are produced during regeneration, but with properly operated afterburners the levels pose no health threat. (See also W90-08509) (Lantz-PTT)
W90-08521

TREATMENT TECHNOLOGIES AND COSTS FOR REMOVING VOLATILE ORGANIC COMPOUNDS FROM WATER: AERATION.
Environmental Protection Agency, Cincinnati, OH. Water Supply Technology Branch.
M. D. Cummins, and J. J. Westrick.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 261-311, 28 fig, 10 tab, 11 ref, append.

Descriptors: *Aeration, *Air stripping, *Mathematical models, *Model studies, *Volatile organic compounds, *Water treatment, Costs, Design standards, Drinking water, Mathematical equations, Organic compounds, Trihalomethanes.

A set of equations has been developed to describe the liquid-phase concentration of volatile compounds as a function of vertical location within a packed column air stripping system. The equation set is constructed to accommodate an unstrippable component, observed in studies of trihalomethanes, in addition to the more typical case of treatment of synthetic volatile contaminants such as trichloroethylene, where there is no unstrippable component. A design procedure was also developed using the theory and supplemented with empirical equations from handbooks. This design procedure is based on desired removal efficiency, VOC properties, liquid flow, liquid temperature, and packing material properties. The areas of uncertainty are Henry's coefficient and mass transfer coefficient. A cost model was also developed to study the economic feasibility and limitations of air stripping. The cost model is based on material quantities (i.e., the mass of steel, volume of concrete, kilowatts of electric power, etc.) required for an air stripping system. The limits of air stripping are evaluated through the use of overall treatment cost. For different site conditions, the same general information would result; i.e., air stripping should be examined as a treatment alternative for compounds ranging in Henry's coefficient from about 0.005 atm cu m/cu m and higher. The process is clearly cost effective for the more volatile compounds, but should not be overlooked as a possible alternative for some of the less volatile contaminants such as benzene and 1,2-dichloroethane. A field evaluation and data analysis procedure is presented which describes a method to estimate basic stripping parameters such as Henry's coefficient and mass transfer coefficient directly from pilot data. Generally, good agreement was obtained for site-specific and predicted mass transfer coefficients using the Onda correlation. (See also W90-08509) (Lantz-PTT)
W90-08522

OXIDATIVE TREATMENT METHODS FOR REMOVAL OF ORGANIC COMPOUNDS FROM DRINKING WATER SUPPLIES.
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
G. R. Peyton.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 313-362, 13 fig, 6 tab, 121 ref.

Descriptors: *Drinking water, *Organic compounds, *Oxidation, *Ozonation, *Volatile organic compounds, *Water treatment, Aromatic compounds, Humic acids, Hydrogen peroxide, Ozone, Ultraviolet radiation.

The number of oxidation processes that have been demonstrated to be of value for the removal of volatile or synthetic organic compounds (VOCs and SOCs) is relatively small. Oxidants or processes which deserve consideration are chlorine, chlorine dioxide, ozone, hydrogen peroxide, advanced oxidation processes, semiconductor-catalyzed photooxidation, ferrate, and permanganate. A very brief overview of these oxidative processes is given before the discussion focuses on ozonation, ultraviolet radiation, and peroxide treatments. Ozone/UV will remove halogenated and aromatic organic compounds from water. Destruction in surface water or groundwater is slower than in distilled or deionized water, probably due to free-radical scavenging by natural water components such as bicarbonate and humic material. The optimum ozone-UV ratio varies with the water and contaminants to be treated, and no general guidelines have been suggested in the literature. In many cases, ozonation in natural water is almost as effective as ozone/UV (or ozone/peroxide), probably due to the presence of natural promoters which establish and sustain the chain reaction conditions for hydroxyl radical production. Peroxide/UV treatment has the following advantages over other advanced oxidation processes (AOPs): (1) the process is very simple; (2) two OH radicals are formed for each peroxide photolyzed; and (3) peroxide is regenerated after OH attack on most organic substrates. Peroxide/UV suffers from the disadvantage that peroxide absorbs UV radiation very weakly at 254 nanometers, and higher intensities are required than with ozone/UV. The UV absorbance of natural water or SOCs may compete effectively for photons. The course of the reaction can be significantly influenced by the presence of oxygen. Bicarbonate interference may be more severe than with other AOPs. (See also W90-08509) (Lantz-PTT)
W90-08523

UNIT PROCESS RESEARCH FOR REMOVING VOLATILE ORGANIC CHEMICALS FROM DRINKING WATER: AN OVERVIEW.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark, R. J. Miltner, C. A. Fronk, and T. F. Speth.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 363-391, 6 fig, 10 tab, 36 ref.

Descriptors: *Aeration, *Drinking water, *Granular activated carbon, *Research priorities, *Volatile organic compounds, *Water treatment, Activated carbon, Adsorption, Organic compounds, Organic matter, Standards.

Amendments to the Safe Drinking Water Act have accelerated the calendar for drinking water regulations. Regulations are increasing in number and stringency, and the time frame for compliance is decreasing. A key factor in establishing maximum contaminant levels (MCLs) is the definition of a feasible technology that can be used to remove a given contaminant in a cost-effective manner. The Drinking Water Research Division (DWRD) of the EPA has a major role in evaluating technologies for meeting drinking water MCLs. Two technologies have been defined as best available for controlling volatile organic chemicals (VOCs). These are granular activated carbon (GA) adsorp-

tion and packed tower aeration. Even though these two technologies have been field tested there is still much to be learned about their performance. For example, DWRD is conducting studies designed to increase the level of understanding concerning competitive adsorption among compounds to be removed by GA. The effect of natural organic matter and its effect on reducing the adsorptive capacity of carbon for specific organics is of concern. Packed tower aeration is a relatively simple technology but increasing concern regarding off-gas control has current research focusing on this issue. It appears that GA can be used at a low relative humidity to remove volatile organics in the gas phase emitted from aerators. Newer technologies that show considerable promise are reverse osmosis, ozonation, and advanced oxidation processes. These technologies will play a major role in the upcoming regulatory process. (See also W90-08509) (Lantz-PTT)
W90-08524

POINT-OF-USE/POINT-OF-ENTRY SYSTEMS FOR REMOVING VOLATILE ORGANIC COMPOUNDS FROM DRINKING WATER.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. W. Lykins, and J. H. Baier.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 393-419, 10 fig, 5 tab, 41 ref.

Descriptors: *Activated carbon, *Domestic water, *Drinking water, *Volatile organic compounds, *Water treatment, Maintenance, Organic compounds, Rural areas, Standards, Water pollution sources.

Point-of-use/point-of-entry (POU/POE) systems have been developed that are effective for removing organic contaminants from drinking water if operated and maintained properly. More homeowners with private drinking water sources are aware of the potential of contamination of these sources and are willing to have them tested. This has led to the identification of many organic compounds in these private drinking water sources. As testing continues, the potential exists for identifying more private drinking water sources that have been contaminated by agricultural use, industrial solvents, leaking gasoline tanks, and hazardous waste sites. Various treatment options are available to the homeowner for removing VOCs although activated carbon is the most widely used POU/POE system. With an increase in the number of households using POU/POE systems, many health departments and other agencies have implemented or are giving serious consideration to centralized control of these systems. This control allows them to establish treatment requirements, operation and maintenance requirements, and proper waste disposal. (See also W90-08509) (Lantz-PTT)
W90-08525

ECONOMIC ANALYSIS OF TREATMENT TECHNOLOGIES TO ACHIEVE VOLATILE ORGANIC CHEMICAL REMOVAL TO SAFE LEVELS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark, and J. Q. Adams.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 421-450, 16 fig, 6 tab, 20 ref.

Descriptors: *Aeration, *Economic aspects, *Granular activated carbon, *Volatile organic compounds, *Water treatment, Activated carbon, Costs, Model studies, Organic compounds, Regulations.

Both granular activated carbon (GAC) and packed tower aeration (PTA) have been designated best available treatment technology in EPA's volatile organic compound (VOC) regulations. Cost and performance models have been developed to examine various treatment scenarios for controlling VOCs. The constant-pattern homogeneous-surface-diffusion model (CPHSDM) was used to pre-

dict liquid-phase GA use rates for selected single-solute VOCs. Eight currently regulated VOCs were examined. Only one of the compounds, p-dichlorobenzene, exhibited a bed life greater than two years, typical of taste-control and odor-control applications using GA. Preliminary cost estimates for liquid-phase GA treatment systems have been developed for a range of plant sizes, empty bed contact times, and carbon bed lives. Most VOCs examined exhibited bed lives of six months or longer. Cost estimates for these scenarios range from about 34-45 cents/1000 gal for a 1 million gallon per day (mgd) system, to about 20-30 cents/1000 gal for a 10-mgd system, to about 11-15 cents/1000 gal for a 100-mgd system. A cost and performance model has been developed to examine various scenarios for controlling VOCs by packed tower aeration including off-gas treatment. Cost-minimized designs were determined by varying parameters such as air-water ratio and pressure drop through the packing media. Preliminary cost estimates for PTA excluding off-gas control varied from about 35-49 cents/1000 gal for a 0.1-mgd system, 21-10 cents/1000 gal for a 1-mgd system, and 14-6 cents/1000 gal for a 10 mgd system. System cost approximately doubles or triples when gas phase GA treatment is included in the PTA system for off-gas control. A comparison was made between liquid phase GA and PTA treatment alternatives. For all VOCs in this analysis, PTA treatment was more cost-effective than liquid phase GA at all system sizes when assuming no PTA off-gas control. When PTA off-gas control was included, cost tradeoffs between PTA and GA were seen at various system sizes. (See also W90-08509) (Lantz-PTT)
W90-08526

EVALUATION OF TOXICITY OF VOLATILE ORGANIC CHEMICALS: GENERAL CONSIDERATIONS.
National Research Council, Washington, DC. Board on Environmental Studies and Toxicology.
R. D. Thomas.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 451-463, 3 tab, 55 ref.

Descriptors: *Drinking water, *Toxicity, *Volatile organic compounds, *Water pollution effects, Animal physiology, Bioassay, Carcinogens, Chloroform, Dichloroethane, Kidneys, Liver, Public health, Tetrachloroethene, Trichloroethene.

Several VOCs are typically found together as contaminants in drinking water samples. These include halogenated chemicals such as tetrachloroethene, trichloroethene, and 1-2-dichloroethane. At high levels, these chemicals produce many of the same pharmacologic and toxic effects, including a narcotic effect on the central nervous system. They are metabolized by the same enzyme systems in the liver and some have been shown to cause liver cancer in rodents, especially mice. Because of the similarities in target organs, these VOCs can be considered a single class for purposes of hazard assessment. The current consensus is to consider chemicals that express their toxicity by similar mechanisms in the same target organs as additive. Among the common systemic toxic effects are liver and kidney disfunction. Chloroform is a good example of this class of substances. Chloroform is metabolized in either the liver or kidneys to reactive intermediates that cause localized tissue damage. Metabolic inhibitors such as SKF-525A decrease the toxicity of chloroform, and compounds such as diethylmaleate potentiate its toxicity on liver and kidney. The VOCs have generally not been shown to be strong mutagens. In most assays either no or weak mutagenic activity has been found. While there is strong evidence that some VOCs, such as chloroform, are carcinogens, many others are not, and the VOCs as a class can not be considered carcinogenic. However, cancer risk assessment of carcinogenic members of the class would be appropriate. (See also W90-08509) (Lantz-PTT)
W90-08527

EPIDEMIOLOGIC STUDIES AND RISK ASSESSMENT OF VOLATILE ORGANIC COMPOUNDS IN DRINKING WATER.
National Cancer Inst., Bethesda, MD. Environmental Epidemiology Branch.
K. P. Cantor.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 465-484, 1 tab, 38 ref.

Descriptors: *Drinking water, *Risk assessment, *Toxicity, *Volatile organic compounds, *Water pollution effects, Benzenes, Bladder, Cancer, Carcinogens, Chlorination, Epidemiology, Human physiology, Organic compounds, Public health, Trihalomethanes, Vinyl chloride.

Epidemiologic studies of occupationally exposed workers are valuable in providing risk information about drinking water contaminants that are also used in industry. Among the VOCs that contaminate drinking water and are major industrial chemicals, there is useful epidemiologic evidence for benzene and vinyl chloride. Human health risk data for other VOCs found in the workplace and drinking water are more limited and not yet suitable for quantitative risk assessment. The direct study of risk in populations exposed to VOCs in drinking water is usually not feasible. In most cases, exposed populations are small, exposures are low, and/or the expected relative risks are too small to be detected, even by large and well-designed studies. However, measurement of risk associated with chlorination by-products in drinking water, including the trihalomethanes (THMs), appears to offer an exception. Large populations are exposed, and relative risks may be great enough to detect. Several geographic correlation studies, and case-control studies based on death certificate information, have suggested elevated risk of bladder, colon, and rectal cancers. One interview study of colon cancer observed no association with trihalomethane level or drinking water source. A large case-control interview study of incident bladder cancer found consistent associations with the level of tap water consumption among long-term users of chlorinated surface water, but not among usual consumers of ground-water. Associations with duration of exposure to chlorinated surface water were also noted. The bladder cancer findings persisted after control for cigarette smoking, occupation, and other bladder cancer risk factors. While these observations require confirmation by additional research, they strongly suggest that elevated bladder cancer risk is associated with consumption of chlorination by-products in drinking water. However, it is not possible to distinguish between VOCs and higher molecular weight by-products in assessing bladder cancer risk. (See also W90-08509) (Lantz-PTT)
W90-08528

TOTAL EXPOSURE TO VOLATILE ORGANIC COMPOUNDS IN POTABLE WATER.
Pittsburgh Univ., PA. Dept. of Industrial Environmental Health Sciences.
J. B. Andelman.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 485-504, 1 fig, 26 tab, 27 ref.

Descriptors: *Drinking water, *Path of pollutants, *Potable water, *Volatile organic compounds, Air pollution, Chloroform, Organic compounds, Public health, Trichloroethylene, Volatilization.

Volatile organic compounds (VOCs) have the potential for causing substantial human exposures from indoor uses of contaminated water by noningestion routes, namely inhalation following volatilization from water, as well as by skin contact. Exposures from contact have been estimated to be comparable to those from direct ingestion of water, although published research in this area is scanty. Measurements in homes have shown that VOCs can be detected in indoor air following the use of contaminated water. Scaled-down and full-size laboratory bath and shower studies for such VOCs as chloroform and trichloroethylene have

shown that a variety of factors can affect the extent of volatilization, found to be typically in the range of 50% to 90%. These include the nature of the volatilizing chemical, water temperature, air and water flow rates, and nature of the water use (e.g., bath vs. shower). The Henry's law equilibrium constants, H, predict that even chemicals with low vapor pressures may be expected to volatilize substantially, provided their water solubilities are also low. Thus, so-called semivolatile organic chemicals have the potential to volatilize and cause inhalation exposures. Also, chemicals with varying H values may nevertheless volatilize at comparable rates. Modeling and estimates of inhalation exposures to VOCs indicate that for the bather these exposures during and directly after a shower can be comparable to that from direct ingestion of the contaminated water. Also, when all water uses are considered, the inhalation exposures to all inhabitants of a home may be substantially larger than that from direct ingestion, even without considering the inhalation exposures at the point of water use. However, additional research is required to quantify these exposures more specifically to encompass the full range of characteristics, as well as personal water uses and occupancy factors. Because the noningestion exposures to VOCs in indoor water uses are likely to be comparable to or greater than those from direct ingestion, it would be prudent to consider this in establishing regulatory limits in drinking water, as well as the need to restrict all indoor water uses when it is judged that there is a significant health risk from the direct ingestion of a contaminated water. (See also W90-08509) (Lantz-PTT)
W90-08529

TOXICOLOGICAL APPROACHES FOR DEVELOPING DRINKING WATER REGULATIONS AND HEALTH ADVISORIES FOR VOLATILE ORGANIC CHEMICALS.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
E. V. Ohanian, and J. P. Glennon.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 505-524, 2 fig, 4 tab, 6 ref.

Descriptors: *Drinking water, *Public health, *Standards, *Toxicology, *Volatile organic compounds, *Water quality control, Chlorinated hydrocarbons, Decision making, Organic compounds, Regulations.

The US EPA Office of Drinking Water (ODW) is engaged in two major programs designed to protect and improve the quality and safety of our nation's drinking water supplies. The first is a regulatory program in which National Primary Drinking Water Regulations are promulgated for contaminants that may pose a risk to human health. The second program provides nonregulatory technical guidance to municipalities, groups and individuals who are faced with drinking water contamination situations which cannot be resolved by applying the existing National Primary Drinking Water Regulations. Both programs rely on the best available information concerning a contaminant's potential to cause adverse health effects in exposed humans. The process used by the ODW to assemble and evaluate toxicological data on contaminants in order to develop both regulatory and guidance values is discussed. The Criteria Document (CD) development process has six general steps (chemical identification, rough draft CD, rough external review draft CD, external review draft CD, final draft CD, and final CD), as does the Health Advisory (HA) development process (chemical identification, rough draft HA, rough external review draft HA, external review draft HA, final draft HA, and final HA). However, the HA process generally takes 12 months to complete, while the CD process takes about 36 months. While ODW's programs encompass the full spectrum of potential drinking water contaminants (including biological contaminants, organic and inorganic contaminants and radionuclides), the focus of the discussion is on volatile organic chemicals for which an extensive toxicological data base exists and considerable regulatory progress has been made. Carbon tetrachloride is used as an example

to demonstrate the toxicological evaluations and extrapolations that are employed when establishing regulations and guidance values. (See also W90-08509) (Lantz-PTT)
W90-08530

RISK MANAGEMENT FOR REGULATORY PURPOSES.
Environmental Protection Agency, Washington, DC. Div. of Water Supply.
For primary bibliographic entry see Field 6E.
W90-08531

PREPARATION OF DRINKING WATER FROM THE SURFACE WATER OF THE DANUBE-A CASE STUDY.
Novi Sad Univ. (Yugoslavia). Inst. of Chemistry.
Z. Hain, B. Dalmacija, D. Miskovic, and E. Karlovic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 253-258, 1990. 2 fig, 5 tab, 7 ref.

Descriptors: *Biological treatment, *Chlorination, *Danube River, *Water treatment, Activated carbon, Drinking water, Pesticides, Polycyclic aromatic hydrocarbons.

Investigations of the removal of organic micropollutants (9 groups, 55 compounds, according to the Environmental Protection Agency classification) from Danube River surface water to produce drinking water were carried out by two procedures. In the first procedure, micropollutants were oxidized with chlorine and the residues removed by powdered activated carbon (PAC). The second procedure involved microbiological oxidation on biologically activated carbon (BAC). It was found that treatment of the Danube River water with 15 mg/cu dm of chlorine in the presence of PAC (60-90 mg/cu dm), followed by coagulation with 51.1 mg/cu dm Al2(SO4)3 and 2.5 mg/cu dm FeCl3 resulted in the removal of the majority of the micropollutants. The BAC system was more efficient than the system involving PAC in removing organic micropollutants, especially those belonging to the pesticides and polyaromatics groups. It is concluded that the BAC system is advantageous with respect to the removal of both total organic load and some micropollutants. (Author's abstract)
W90-08639

5G. Water Quality Control

TEXAS RAILROAD COMMISSION OIL AND GAS DIVISION UNDERGROUND INJECTION CONTROL PROGRAM: A PEER REVIEW.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-012488. Price codes: A08 in paper copy, A01 in microfiche. Report No. DOE/BC/14304–T2, 1989. 196p.

Descriptors: *Groundwater pollution, *Injection wells, *Oil industry, *Peer review, *Texas, *Water pollution prevention, Compliance, Handbooks, Natural gas, Regulations, Wastewater disposal.

Peer reviews have been applied in various programs and professions for many years as an effective evaluation process. In this peer review process, member states of the Underground Injection Practices Council (UIPC), the US EPA and the US Department of Energy (DOE) attempt to look at the major groundwater protection effort of state regulatory agencies, their underground injection control (UIC) programs. The reports included in this document are the result of this effort to evaluate the effectiveness of state programs to protect underground sources of drinking water (USDW) from potential contamination resulting from the operation of injection wells related to the production of oil and gas (Class II injection wells). The programs examined cover wells which are used for the injection of fluids into oil reservoirs for the purpose of stimulating or furthering their production when natural production mechanisms decline or cease (enhanced recovery well) and for the disposal of waters produced in conjunction with the production of oil and gas (disposal wells). If improperly constructed, operated, maintained, or

abandoned, such wells may allow contaminants to enter USDWs potentially depriving the public of needed sources of current or future water supplies. A review questionnaire workbook was prepared containing numerous questions about the important aspects of a state's Class II UIC program including: (1) permitting and file review; (2) inspections; (3) mechanical integrity testing; (4) compliance and enforcement; (5) plugging and abandonment; and (6) inventory and data management. The Review Team reviewed the written Workbook response, oral responses given during a visit to the responsible State regulatory agency, and various documents supplied by the States and prepared reports of the findings and conclusions. The report and supporting documentation for Texas are given in this document. (Lantz-PTT)
W90-07507

ERIE AND CAMPBELL LAKES. FINAL REPORT: RESTORATION IMPLEMENTATION AND EVALUATION.
Entranco Engineers, Inc., Kirkland, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-208805. Price codes: A10 in paper copy, A01 in microfiche. December 1987. 186p, 27 fig, 21 tab, 56 ref, 7 append.

Descriptors: *Aquatic weed control, *Campbell Lake, *Erie Lake, *Lake restoration, *Phosphorus removal, *Washington, *Water quality control, Chlorophyll a, Eutrophic lakes, Eutrophication, Fishkill, Lake sediments, Secchi disks, Transparency.

Erie and Campbell Lakes are located on Fidalgo Island in Skagit County, Washington. Both lakes are considered shallow and generally remain unstratified throughout the year. The lakes lie within a relatively undisturbed watershed, and Erie Lake drains into Campbell Lake. In 1981, a Phase I Diagnostic Study was initiated to assess the nature and extent of water quality problems in Erie and Campbell Lakes. Both lakes suffered from dense blooms of blue-green algae, and Erie Lake also experienced occasional fish kills. The study identified phosphorus (P) as the nutrient controlling algal growth, and sediment phosphorus release represented the most significant controllable source of P to both lakes. The recommended Phase II restoration plan contained four major elements: (1) aluminum sulfate (alum) treatment; (2) mechanical plant harvesting; (3) watershed management plan; and (4) performance monitoring. In 1985, Skagit County received a $649,800 grant to conduct the Phase II implementation of the restoration plan. Both lakes were treated with liquid alum during fall 1985 in order to reduce internal P loading from the sediments and mechanical harvesting was implemented on both lakes in summer 1986 (38 wet tons of plant material was harvested from Erie Lake and 581 wet tons from Campbell Lake). The 1986 post-restoration summer values indicate a dramatic improvement in the quality of Erie Lake. Mean summer total P concentrations were reduced by 77%, chlorophyll-1 concentrations were reduced by 91%, and Secchi depth visibility increased by at least 47%. The traditional late summer blue-green algae bloom, which had produced peak chlorophyll-a concentrations of 337 micrograms/L, was totally averted in 1986, and recreational opportunities were greatly enhanced. Marked improvements in Campbell Lake were also observed, although not to the extent of Erie Lake. Mean summer total P concentrations were reduced by 43%, chlorophyll-a concentrations were reduced by 44%, and Secchi depth visibility increased by 16%. A 63% reduction in peak chlorophyll-a levels was also observed. (Lantz-PTT)
W90-07508

HYDE PARK LAKE RESTORATION PROJECT, NIAGARA FALLS, NEW YORK.
New York State Dept. of Environmental Conservation, Albany.
C. R. Pettit, D. J. Johnston, and V. R. Frederick.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-210017. Price codes: A10 in paper copy, A01 in microfiche.

February 1982. 206p, 23 fig, 1 tab, 13 ref, 2 append. EPA Grant S-805-786-01-0.

Descriptors: *Bank stabilization, *Dredging, *Hyde Park Lake, *Lake restoration, *New York, Booms, Dams, Erosion control, Flow regulators, Gill Creek, Monitoring, Riprap, Sedimentation, Settling basins, Water pollution control.

The Hyde Park Lake Restoration Project represents a major, effort to restore the lake and surrounding area to a condition that allows area residents to enjoy the beauty and recreational advantages of Hyde Park Lake and Gill Creek. The Hyde Park Lake Restoration Project, one of the largest completed in New York State, includes several key elements: (1) pre-construction environmental impact studies and identification; (2) engineering and construction; (3) environmental and biological studies during entire construction phases; and (4) post-construction environmental studies and evaluations, including preparation of the project report. Engineering and construction improvements included the removal of polluted lake water and the excavation of lake bottom muck and clay; the clay was utilized as a 'liner' of existing secured landfills. Pre-construction and post-construction studies, along with several investigations undertaken during the construction period, verified the improved water and environmental quality over the construction phases. Construction of a siltation (settling) pond with a trash collector and an oil boom ensures the prevention of silt and trash from entering the lake via its tributary--Gill Creek. In addition, the oil boom collects and absorbs any oil entering the creek upstream, at the settling pond site. Stone riprap and new vegetation provide stabilization of the surrounding soil area to aid in preventing erosion. Continuous fresh water flow will be obtained from a nearby reservoir via a unique augmentation system, providing clean water continually to the lake. (Lantz-PTT)
W90-07509

GORTON POND, WARWICK, RHODE ISLAND, LAKE RESTORATION PROJECT. PHASE I: DIAGNOSTIC/FEASIBILITY STUDY.
Keyes Associates, Providence, RI.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-209159. Price codes: A13 in paper copy, A01 in microfiche. 294p, 25 fig, 30 tab, 17 ref, 5 append. EPA Project 5001-295-010.

Descriptors: *Gorton Pond, *Lake restoration, *Rhode Island, *Water pollution treatment, *Water quality control, Aquatic weed control, Coliforms, Dredging, Erosion control, Fertilizers, Nutrients, Oil pollution, Storm runoff, Urban areas, Urban runoff, Wastewater disposal, Watershed management.

Gorton Pond watershed lies within the City of Warwick, Rhode Island, and has a surface area of 57 acres and a total volume of 855 acre-ft. Gorton Pond is classified as a Class B water according to the Rhode Island Water Quality Standards. This designation signifies that the pond can be utilized for both primary and secondary contact recreation. In addition, this class is designated for protection and propagation of fish, other aquatic life and wildlife. Water use of Gorton Pond is varied. The pond basin serves as a drainage sink for its surrounding watershed and as such receives the surface runoff from 790 acres of urban land developed as residential, commercial and industrial space with an attendant road network. Because of its urban setting, it receives surface runoff waters that are contaminated with oil, grease, coliforms, fertilizers and other waste products that wash off the land and are carried to the pond by storm drains. The present populations of aquatic birds and mammals that inhabit Gorton Pond are considered normal for urban waters. These populations are not expected to change their species complement with pond restoration and if fishery resources are increased at the pond, it is possible that a greater variety of aquatic birds may appear. The greatest percentage of the Gorton Pond watershed is sewered, however, a small enclave of homes with-

out sewers do exist, including some which are very close to Gorton Pond. These on-site wastewater disposal systems in the Gorton Pond watershed, even though limited, cause water quality problems due to subsurface conditions. On the basis of data collected and analyzed to date, the following elements for the restoration of Gorton Pond were recommended: Out of lake--(1) a comprehensive storm water management plan to reduce urban runoff pollutants; (2) the eventual sewering of the immediate area tributary to Gorton Pond, especially along those streets close to the lake; and (3) enforcement of existing erosion and sediment control regulations and their regulatory extension to all activities within the Gorton Pond basin; in-lake--(1) nutrient inactivation and/or precipitation with adequate pH control; (2) limited dredging along the inlet area, outlet area, and selected coves; and (3) limited weed harvesting to assist dredging efficiency and to provide access in areas where a muck or sand bottom is not otherwise problematic. (Lantz-PTT)
W90-07512

LAKE RONKONKOMA CLEAN LAKES STUDY.
Suffolk County Dept. of Health Services, Hauppauge, NY.
L. E. Koppelman, and C. S. Swick.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-210025. Price codes: A06 in paper copy, A01 in microfiche. January 1986. 184p, 51 fig, 55 tab, 90 ref, append. EPA Grant C000433.

Descriptors: *Lake Ronkonkoma, *Lake restoration, *New York, *Water pollution control, Lake management, Land use, Recreation, Regulations, Septic wastewater, Storm runoff, Wastewater management, Water sampling, Zoning.

The problems at Lake Ronkonkoma, Suffolk County, New York, are not unique for a freshwater lake located in an urbanized area. Pollution, flooding, a high water table, destruction of vegetation, erosion, noise resulting from improper use, littering and illegal dumping, inadequate roads, and poorly designed or unauthorized access which results in erosion and destruction of vegetation, are common occurrences. The following goals and objectives were developed as a result of numerous meetings with other agencies and private citizens, the water quality investigations and a study of conditions surrounding the lake: (1) protect lake water quality; (2) protect the wetlands; (3) protect and maintain existing natural vegetation and provide additional water protection; (4) enhance the Lake Ronkonkoma Park system; (5) provide additional park facilities; and (6) provide needed controls for the new park system. Recommendations to implement these goals include: stormwater runoff management; zoning; proposed acquisitions; parkland and facilities management; septic system management; and, right of first refusal. (Lantz-PTT)
W90-07515

LAKE SACAJAWEA RESTORATION PROJECT, CITY OF LONGVIEW, WASHINGTON.
Gibbs and Olson, Inc., Longview, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-209977. Price codes: A06 in paper copy, A01 in microfiche. Final Project Report on Alternative Water Supply Study, February 1985. 199p, 29 fig, 16 tab, 6 plates, 11 ref, 4 append.

Descriptors: *Lake Sacajawea, *Lake restoration, *Surface-groundwater relations, *Washington, Cowlitz River, Dredging, Eutrophic lakes, Groundwater movement, Groundwater quality, Hydrologic budget, Iron, Mixing, Nitrogen, Nutrients, Phosphorus, Seasonal variation, Secchi disks, Storm runoff, Stratification, Turbidity, Water pollution control.

The City of Longview, Washington, has successfully completed a three part restoration program for Lake Sacajawea consisting of: (1) diversion of stormwater runoff away from the lake; (2) con-

struction of a new lake water supply line and pump station located near the Cowlitz River; and (3) dredging the lake to remove nutrient rich sediment. Construction of the stormwater diversion line and dredging the lake have dramatically decreased the seasonal and yearly mean nitrogen concentrations. Nitrate and ammonia loadings were both reduced as a result of the diversion program while dredging has reduced ammonia release from the sediment during stratification. The P concentration has increased since the dredging operation and no longer controls the productivity of the lake since algal growth now appears to be N limited. Since 1981, the lake has experienced increasing Secchi disk transparency readings while concurrently showing lower chlorophyll-a concentrations. Mean summer chlorophyll-a concentrations indicate a shift from a eutrophic lake to a mesotrophic lake following restoration. However, Secchi Disk transparency is still in the eutrophic range of < 80 inches. The hydrologic budget indicates that almost 87% of the water entering the lake is from the surrounding groundwater. This groundwater was sampled and found to contain high concentrations of P. It is believed the groundwater contributes significantly to the P concentration found in the lake and is responsible for the strong stratification seen in the lake from March to October (i.e., cold water continuously enters the bottom of the lake under the warm surface water). The high Fe concentrations in the groundwater are responsible for the turbid conditions found in the lake during winter months. Upwelling, caused by heavy rains increasing the groundwater flow, carries in water with high concentrations of dissolved Fe. The Fe quickly oxidizes and produces the brownish red turbidity observed during wet winter months. (Lantz-PTT)
W90-07516

DELAVAN LAKE: A RECOVERY AND MANAGEMENT STUDY. WATER RESOURCES MANAGEMENT WORKSHOP.
Wisconsin Univ.-Madison. Inst. for Environmental Studies.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-210470. Price codes: A17 in paper copy, A01 in microfiche. September 1986. 365p, 41 fig, 51 tab, 192 ref, 8 append.

Descriptors: *Delavan Lake, *Eutrophic lakes, *Lake restoration, *Phosphorus removal, *Water pollution control, *Wisconsin, Agricultural runoff, Alum, Cyanophyta, Fisheries, Long-term planning, Nutrients, Path of pollutants, Sediment contamination, Urban runoff, Water pollution sources, Water resources management.

The decline in water quality at Delavan Lake, resulting in severe blue-green algae blooms and excess numbers of rough fish, is a reflection of the lake's response to increased nutrient levels. There are two basic sources of P at Delavan Lake--external and internal. Important external sources include: agricultural runoff; runoff from land immediately adjacent to the lake; urban runoff from Elkhorn; and point source inputs from Elkhorn. Important internal sources include: release of dissolved-P from lake sediments in deep water areas; and, release from lake sediments caused by the feeding activities of rough fish in shallow areas. Lake restoration techniques are available to correct the water quality and fishery problems at Delavan Lake. These alternatives fall into three general categories: reduction of nutrients derived from the watershed; reduction of in-lake sources of nutrients; and managing the biological consequences of a nutrient-rich lake. Four different management approaches were formulated that range from relatively simple and low cost, to complex and costly. The final recommended plan has four components: (1) inflow short-circuiting--the purpose of enhancing short-circuiting is to prevent nutrient-rich water from mixing with the lake; (2) in-lake nutrient control--applications of alum to Delavan Lake to remove P from lake water and seal P into bottom sediments; (3) fishery rehabilitation; (4) and long-term protection and maintenance. (Lantz-PTT)
W90-07517

HANDBOOK OF LIMNOLOGY.
Freiburg Univ. (Germany, F.R.).
For primary bibliographic entry see Field 2H.
W90-07550

WELL INSTALLATION AND GROUND-WATER SAMPLING PLAN FOR 1100 AREA ENVIRONMENTAL MONITORING WELLS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 7A.
W90-07552

INFLUENCE OF LAKE RESTORATION MEASURES ON WATER QUALITY AND WATER QUANTITY IN BLUE LAKE, IOWA. OXBOW LAKE STUDY: PHASE III.
Iowa State Water Resources Research Inst., Ames.
R. A. Lohnes, R. W. Bachmann, and T. A. Austin.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-210074.
Price codes: A04 in paper copy, A01 in microfiche.
Report No. ISWRRI-130, June 1982. 49p, 6 fig, 9 tab, 5 ref, 2 append.

Descriptors: *Iowa, *Lake restoration, *Oxbow lakes, *Water quality, Blue Lake, Dissolved oxygen, Dredging, Macrophytes, Pumping, Sediment contamination, Storage capacity, Wells.

Blue Lake, 48 km (30 miles) south of Sioux City, Iowa, is one of four oxbow lakes on the floodplain of the Missouri River which provide important recreational resources to the people of western Iowa and eastern Nebraska. The other lakes are Brown's Lake, DeSoto Bend, and Lake Manawa. It was recognized in the mid-1970s that all of these lakes have problems associated with poor water quality and/or limited water quantity. Blue Lake was the first of the group to have management recommendations implemented, and this report describes the effect of the restoration measures based upon observations covering one year after the measurers were put into effect. Dredging removed 286,000 cu m of sediment in the northern portion of the lake, thereby increasing the lake volume nearly 25%. The dredging was consistent with the design and should have no significantly detrimental effect on groundwater seepage from the lake. Observations of lake levels and pumping rates confirm the prediction made with a finite difference seepage model. Namely, a pumping rate of 1,400,000 cu m/yr will maintain the lake level at elevation 316 m MSL. The relocation of the well has increased the pumping efficiency from < 10% to nearly 12.5%. The combined effects of dredging and new supplemental source have increased the storage capacity of the lake about 39%. Biological predictions from earlier reports have been borne out in that the water quality of the lake is good; however, aquatic macrophytes and poor oxygen supply continue to prohibit the best recreational use of the lake. (Lantz-PTT)
W90-07556

WAPATO LAKE RESTORATION: A DISCUSSION OF DESIGN CONSIDERATIONS, CONSTRUCTION TECHNIQUES AND PERFORMANCE MONITORING.
Entranco Engineers, Inc., Kirkland, WA.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-209969.
Price codes: A10 in paper copy, A01 in microfiche.
Final Report, December 1986. 272p, 85 fig, 14 tab, 40 ref, 5 append.

Descriptors: *Lake restoration, *Monitoring, *Wapato Lake, *Water quality control, Algal blooms, Coliforms, Design standards, Drawdown, Dredging, Eutrophic lakes, Nutrients, Storm water management, Turbidity, Washington, Wetlands.

Wapato Lake is a small, 30-acre lake located in an urbanized area of Tacoma, Washington. Historically, the lake has reflected high concentrations of fecal coliform bacteria, toxic metals, oil and grease, turbidity (cloudy water), nutrients, and algae growth. These have interfered with swimming, boating, fishing and overall aesthetic quality of the lake. The Metropolitan Park District of Tacoma, in cooperation with the State of Washington Depart-

ment of Ecology and the US EPA, sponsored a series of water quality and engineering investigations. After consideration of several alternatives, the Park District adopted a restoration program consisting of the following elements: (1) gradual dilution of the south (recreational) basin of the lake with nutrient poor municipal water during the summer recreational months; (2) stormwater detention and treatment in the north basin and adjacent wetlands through construction of a berm/overflow spillway between the two lake basins; (3) diversion of most stormflow around the lake, especially during the period when dilution was occurring; (4) limited dredging of storm sewer outfall areas to optimize sedimentation characteristics there; and (5) a drastic drawdown of lake level to consolidate bottom sediments and facilitate restoration construction activities. In addition, an aluminum sulfate application was performed on the south basin of the lake in the summer of 1984 to supplement the dilution program. Wetlands treatment and diversion of stormwater was demonstrated to be a very successful element of the restoration program. Wetlands treatment and downstream diversion was estimated to reduce annual stormwater inflow and resultant P loading to the south basin by > 90%. While some trophic quality improvements in the south basin were demonstrated, summer blue-green algal blooms continued to persist due to the unavailability of satisfactory dilution water and major changes in the lake's ecological characteristics. The aluminum sulfate application in 1984 was intended to supplement dilution by retarding P release from sediments. However, the application's effectiveness was subverted by the concurrent resurgence of aquatic plant growth in the south basin. (Lantz-PTT)
W90-07559

HANDBOOK OF GROUNDWATER PROTECTION.
Illinois State Water Survey Div., Champaign.
M. Barcelona, J. F. Keely, W. A. Pettyjohn, and A. Wehrmann.
Hemisphere Publishing Corporation, New York. 1988. 212p.

Descriptors: *Groundwater pollution, *Groundwater quality, *Handbooks, *Water pollution control, *Water pollution prevention, Cleanup operations, Geohydrology, Model studies, Monitoring, Water sampling, Well construction.

The subsurface environment of groundwater is characterized by a complex interplay of physical, geochemical and biological forces that govern the release, transport and fate of a variety of chemical substances. There are literally as many varied geohydrologic settings as there are types and numbers of contaminant sources. The impact of natural groundwater recharge and discharge processes on distributions of chemical constituents is understood for only a few types of chemical species. Also, these processes may be modified by both natural phenomena and man's activities so as to further complicate apparent spatial or temporal trends in water quality. One purpose of this document is to discuss measures that can be taken to ensure that uncertainties do not undermine the ability to make reliable predictions about the response of contamination to various corrective or preventive measures. This handbook is divided into nine chapters, to facilitate the discussions about the framework for protecting groundwater resources, and assessing and protecting the quality of groundwater resources. The chapters are: (1) groundwater contamination; (2) groundwater quality investigations; (3) groundwater restoration; (4) basic geohydrology; (5) monitoring well design and construction; (6) groundwater sampling; (7) groundwater tracers; (8) use of models in managing groundwater protection programs; and (9) basic geology. (Lantz-PTT)
W90-07561

RESTORATION OF THE POND IN CENTRAL PARK, MANHATTAN, NEW YORK CITY.
New York City Dept. of Parks and Recreation.
Capital Projects Div.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-208730.

Price codes: A04 in paper copy, A01 in microfiche.
( ). 35p, 17 fig, append. EPA Grant 5804908-01-03.

Descriptors: *Eutrophic lakes, *Lake restoration, *New York City, *Sedimentation, *Water quality, Algal blooms, Dredging, Riprap, Storm drains, Water circulation, Weirs.

A man-made pond, approximately 1.6 hectares in size, located in the southeast corner of the 340 hectare Central Park, New York City was restored. The Pond is primarily for passive recreation although it is used for ice skating in the winter (when the thickness of the ice is adequate). In recent years the Pond has exhibited the symptoms of cultural eutrophication with growing amounts of sediment, macrophytes, algae blooms, debris, and litter. To regain functional and aesthetic usage of the Pond, the source of the problem was addressed. The specific method was to drain the Pond, remove the sediment for use in a landfill project, construct a riprap perimeter wall, construct weirs, silting basins and rehabilitate the storm drain system. In addition, other rehabilitation work being done in the watershed area will do a great deal to curtail erosion and prevent the build-up sediment in the drainage system and Pond. The rehabilitation and restoration of the Central Park Pond was about essential and successful. Initial identification of the main factor contributing to the eutrophic condition of the Pond was excessive sediment on the bottom of the Pond. To correct this situation approximately 20,713 cu yd of sediment material was excavated from the lake and removed from the site. The deteriorated perimeter riprap wall was reconstructed and extended to insure against future deterioration and the erosion of topsoil and other materials into the lake. The drainage system was rehabilitated, cleaned and weirs and silting beds were provided. These measures should do a great deal to eliminate soil erosion and the depositing of sediment and other undesirable substances into the lake. The removal of silt and deepening of the Pond has improved water flow and circulation. (Lantz-PTT)
W90-07563

COLUMBIA LAKES DIAGNOSTIC-FEASIBILITY STUDY.
Browne (F.X.) Associates, Inc., Lansdale, PA.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-209217.
Price codes: A06 in paper copy, A01 in microfiche.
June 1982. 114p, 29 fig, 21 tab, 40 ref.

Descriptors: *Eutrophic lakes, *Feasibility studies, *Lake restoration, *Maryland, *Water quality control, Algal blooms, Chlorophyll a, Eutrophication, Lake Elkhorn, Lake Kittamqundi, Nonpoint pollution sources, Phosphorus, Sediment transport, Sedimentation, Transparency, Waterfowl, Wilde Lake.

Wilde Lake, Lake Kittamqundi and Lake Elkhorn are located in the planned community of Columbia, Maryland, and are part of the Columbia wide open space system. Water quality in all of the lakes has deteriorated. Algal blooms occur throughout the summer, and sediment has accumulated in the lakes. Eutrophication has impaired aesthetics and the use of the lakes. In 1980 a Phase I Clean Lakes grant was awarded by the EPA. The Phase I Diagnostic-Feasibility Study for the three lakes was completed in December 1982. Although the lakes and their watersheds are in close proximity to each other, they have different physical, hydrologic and biologic characteristics. Each lake, therefore, requires a distinct restoration approach. The Phase I study recommendations emphasize measurers that eliminate the causes of eutrophication by reducing nonpoint source loads of P and sediment to the lakes. Regional controls that trap sediment and nutrients, such as sediment ponds and man-made wetlands, should be constructed upstream of Lakes Wilde and Elkhorn. Pollutant loads to Lake Kittamqundi should be reduced by improving the water quality of the outflow from Wilde Lake and by reducing the frequency of flooding from the Little Patuxent River. Source controls like street sweeping should be initiated in a~·· ·~· drained by the wetland or sediment ponds, an.. the unnatu-

rally large populations of waterflow should be reduce. In-lake management and restoration activities including localized dredging and selective discharge should be implemented concurrently with regional and source controls. Implementation of the recommendations will benefit the large local and tourist populations that enjoy the fishing, boating, and aesthetic opportunities offered by the lakes. The proposed program will provide long-term reductions in nutrient loads to the lakes and long-term improvements in water quality. The proposed restoration program for Wilde Lake, Lake Kittamqundi and Lake Elkhorn is expected to decrease in-lake P concentrations by 33, 28 and 35%; and transparency will be increased by 50, 39 and 53%. (Lantz-PTT)
W90-07565

AGRICULTURAL CHEMICALS AND GROUND WATER QUALITY--ISSUES AND CHALLENGES.
Arizona State Univ., Tempe. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W90-07598

MODELING MANAGEMENT PRACTICE EFFECTS ON PESTICIDE MOVEMENT TO GROUND WATER.
Maryland Univ., College Park. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W90-07602

BIODEGRADATION OF 2-CHLOROPHENOL USING IMMOBILIZED ACTIVATED SLUDGE.
New Jersey Inst. of Tech., Newark. Biotechnology Research Group.
For primary bibliographic entry see Field 5D.
W90-07629

TREATMENT AND DISCHARGE TO A POTW: THE STRINGFELLOW EXPERIENCE.
Environmental Protection Agency, San Francisco, CA. Region IX.
B. J. Ullensvang, and U. P. Singh.
Water Environment & Technology WAETEJ, Vol. 2, No. 1, p 37-43, January 1990. 3 fig, 3 tab.

Descriptors: *Groundwater pollution, *Heavy metals, *Industrial wastewater, *Pretreatment of wastewater, *Superfund, *Wastewater disposal, *Wastewater facilities, *Water pollution treatment, Cleanup operations, Land disposal, Organic compounds, Organic solvents, Sludge, Trichloroethylene, Wastewater farming.

The Stringfellow Superfund site in Riverside, California received approximately 34 million gallons of industrial wastes from 1956 to 1972. The wastes were primarily from metal finishing, electroplating, and DDT production. A fast-track RI/FS was conducted in 1983-1984 and during this time contaminated groundwater was pumped at an average rate of 150,000 gallons per week. The water was routed to a series of holding tanks and then trucked to a Class I disposal facility. The water table aquifer had been contaminated to a point at least 4,000 feet down the canyon. High heavy metals concentrations were detected at monitoring wells located within the original disposal site and immediately downgradient. A wide range of organic pollutants was detected in groundwater downgradient of the disposal site, with trichloroethylene the main pollutant. Calculations indicated that downgradient private wells would be degraded to below potable water standards within a few years. An endangerment assessment indicated that interim extraction of contaminated groundwater was necessary prior to the completion of the full scale RI/FS. The remediation plan included onsite pretreatment, trucking effluent to a publicly owned treatment works (POTW) for secondary treatment, and disposing of the pretreatment sludge at a Class I facility. The pretreatment standards were set by the POTW, utilizing existing standards for the metal finishing industry. The interim remedial actions have been incorporated into the final groundwater cleanup plan. (Tappert-PTT)

W90-07633

PRICING OF WATER RESOURCES WITH DEPLETABLE EXTERNALITY: THE EFFECTS OF POLLUTION CHARGES.
Institute of Socio-Economic Planning, University of Tsukuba, Tsukuba, Ibaraki, Japan.
For primary bibliographic entry see Field 6E.
W90-07664

FATE OF NITROGENOUS FERTILIZERS APPLIED TO TURFGRASS.
A. M. Petrovic.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 1-14, 1990. 5 fig, 5 tab, 39 ref.

Descriptors: *Fertilizers, *Groundwater pollution, *Nitrogen compounds, *Nutrient transport, *Path of pollutants, *Surface-groundwater relations, *Turf grasses, Grasses, Lawns, Leaching, Literature review, Nitrogen removal, Runoff, Soil analysis, Volatility.

Maintaining high quality surface and groundwater supplies is a national concern. Nitrate is a widespread contaminant of groundwater. Nitrogenous fertilizer applied to turfgrass could pose a threat to groundwater quality. However, a review of the fate of nitrogen (N) applied to turfgrass is lacking, but needed in developing management systems to minimize groundwater contamination. The discussion of the fate of N applied to turfgrass is developed around plant uptake, atmospheric loss, soil storage, leaching, and runoff. The proportion of the fertilizer N that was taken up by the turfgrass plant varied from 5 to 74% of applied N. Uptake was a function of N release rate, N rate and species of grass. Atmospheric loss, by either NH3 volatilization or denitrification, varied from 0 to 93% of applied N. Volatilization was generally less than 35% of applied N and could be reduced substantially by irrigation after application. Denitrification was only found to be significant (93% of applied N) on fine-textured, saturated, warm soils. The amount of fertilizer N found in the soil plus thatch pool varied as a function of N source, release rate, age of site, and clipping management. With a soluble N source, fertilizer N found in the soil and thatch was 15 to 21% and 21 to 26% of applied N, respectively, with the higher values reflecting clippings being returned. Leaching losses for fertilizer N were highly influenced by fertilizer management practices (N rate, source, and timing), soil texture, and irrigation. Highest leaching losses were reported at 53% of applied N, but generally were far less than 10%. Runoff of N applied to turfgrass has been studied to a limited degree and has been found seldom to occur at concentrations above the federal drinking water standard for nitrate ion (NO3(-)). Where turfgrass fertilization poses a threat to groundwater quality, management strategies can allow the turfgrass manager to minimize or eliminate nitrate leaching. (Author's abstract)
W90-07696

RUNOFF OF SULFOMETURON-METHYL AND CYANAZINE FROM SMALL PLOTS: EFFECTS OF FORMULATION AND GRASS COVER.
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Lab.
R. D. Wauchope, R. G. Williams, and L. R. Marti.
Journal of Environmental Quality JEVQAA, Vol. 19, No. 1, p 119-125, 1990. 3 fig, 5 tab, 22 ref.

Descriptors: *Agricultural runoff, *Cyanazine, *Herbicides, *Path of pollutants, *Rainfall-runoff relationships, Application rates, Leaching, Simulated rainfall, Simulation analysis, Vegetation.

To determine the effects of application rates, grass cover, and formulation type on herbicide losses in runoff, 4.5 kg/ha cyanazine (2-((4-chloro-6-(ethylamino)-1,3,5-triazin-2-yl))amino)-2-methylpropanenitr ile) with 0.4 kg/ha sulfometuron-methyl (methyl-2-(((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)amino)sulfonyl)ben zoate) were applied to 1.2 by 2.4 m plots, using suspension concentrate (SC) and dispersible granule (DG) formulations of cyanazine, and SC and

emulsifiable concentrate (EC) formulations of sulfometuron-methyl. The plots were established on a Tifton loamy sand soil (fine-loamy, siliceous, thermic Plinthic Paleudults) and had 3% slope. The plots were bare or covered with a mixed stand of common Bermudagrass (Cynodon dactylon (L.) Pers.) and Bahiagrass (Paspalum notatum Flugge var. suarae Parodi). On the day after the herbicides were applied rainfall events of 69 mm/hour intensity were simulated until 2 mm of runoff occurred. The runoff was analyzed for sediment and herbicides. The bare plots required one-third less rain to produce the same amount of runoff and yielded twice as much sediment as the grassy plots. However, losses of all formulations were 1 to 2%-of the amounts applied regardless of grass cover even though cyanazine rates were 11 times that of sulfometuron-methyl. Total losses of all formulations were sensitive to the length of time between rainfall initiation and runoff initiation, indicating that leaching made herbicide unavailable for runoff. These results suggest that, for these formulation under conditions of similar runoff volumes, losses of pesticides are a fairly constant fraction of the amounts applied, with or without grass cover. For intense storms where the amount of rainfall is similar, chemical runoff from the grassed plots was predicted by computer simulation to be less than half of that from bare soil. (Author's abstract)
W90-07705

VOLATILIZATION OF SELENIUM FROM AGRICULTURAL EVAPORATION POND WATER.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-07706

NONPOINT SOURCE PHOSPHORUS CONTROL BY A COMBINATION WET DETENTION/FILTRATION FACILITY IN KISSIMMEE, FLORIDA.
Smith and Gillespie Engineers, Inc., Sarasota, FL.
J. D. Holler.
Florida Scientist FLSCAQ, Vol. 53, No. 1, p 28-37, Winter 1990. 2 fig, 5 tab, 4 ref.

Descriptors: *Detention reservoirs, *Nonpoint pollution sources, *Phosphorus, *Urban runoff, *Water pollution control, *Water treatment, Filtration, Florida, Kissimmee, Phosphates, Storm water management, Water quality.

Water quality investigations were conducted to assess the treatment potential (concentration reduction) of a dual-component wet detention/filtration-berm stormwater management system, located in Kissimmee, Florida. Phosphorus concentrations are indicative of nonpoint source pollution in urban and commercial stormwater runoff. Therefore, orthophosphorus and total phosphorus concentrations were monitored at three different sampling stations within the system : (i) surface runoff influent channel; (2) wet detention basin standing pond; and (3) filtration-berm effluent collection box. Routine monthly data were collected to characterize prevalent ambient conditions. In addition, six distinct storm events were monitored with automatic samplers to characterize episodic phosphorus variations during the period November 1985 to November 1986. Statistical analyses (t-test) of routine monthly concentration data showed significant differences (p < or = 0.05) between the stormwater influent and the wet detention basin standing pool samples for both orthophosphorus and total phosphorus. However, similar analyses between detention basin standing pool and filtration-berm effluent samples showed no significant differences. These results suggest positive treatment potential attained through wet detention, but significant additional treatment was not realized through berm filtration. Storm event results reinforced these conclusions, indicating that wet detention treatment potential far superior to filtration-berm treatment potential. The average storm event treatment potential realized by wet detention during six events for orthophosphorus and total phosphorus was 77%. The average treatment potentials realized by filtration for orthophosphorus and total

phosphorus were -91% and 16%, respectively. The average treatment potentials realized by the overall combined system for orthophosphorus and total phosphorus were 55% and 85%, respectively. (Author's abstract)
W90-07877

LANDFILLS - A THING OF THE PAST.
Camp, Dresser and McKee, Inc., Clearwater, FL.
R. C. Johnson.
Florida Scientist FLSCAQ, Vol. 53, No. 1, p 74-80, Winter 1990. 6 ref.

Descriptors: *Groundwater pollution, *Landfills, *Legislation, *Water pollution control, *Water pollution sources, Legal aspects, Liners, Monitoring.

Generally, groundwater contamination is a reality associated with landfills constructed prior to about 1980-84. In some cases this contamination has reached public and private drinking water supplies. State laws adopted in the mid-1980's requiring groundwater monitoring at all landfills have accelerated the discovery of groundwater contamination problems associated with landfills. In addition, federal investigations under Superfund have identified sources of contamination and in some cases provided funds for remedial action at these sites. Remedial action is also being conducted by the state of Florida, municipalities and the private sector. For the past 4-5 years, landfills have been constructed in a manner that greatly reduces the potential for groundwater contamination through the use of liner systems, slurry walls, leachate collection and detection systems, and mandatory groundwater monitoring. However, there is a trend in Florida to reduce the reliance on the use of landfills by increasing the use of recycling and energy recovery systems. (Author's abstract)
W90-07878

USE OF HUMIC ACID SOLUTION TO REMOVE ORGANIC CONTAMINANTS FROM HYDROGEOLOGIC SYSTEMS.
General Motors Research Labs., Warren, MI. Environmental Science Dept.
A. S. Abdul, T. L. Gibson, and D. N. Rai.
Environmental Science and Technology ESTHAG, Vol. 24, No. 3, p 328-333, March 1990. 5 fig, 3 tab, 21 ref.

Descriptors: *Cleanup operations, *Groundwater pollution, *Humic acids, *Hydrocarbons, *Organic solvents, Aromatic compounds, Benzene, Chemical interactions, Organic compounds, Organic wastes, Sand, Toluene, Water pollution treatment.

Experiments were carried out to evaluate the effectiveness of a 29 mg/L solution of humic acid to enhance the removal of six aromatic hydrocarbons (benzene, toluene, p-xylene, ethyltoluene, sec-butylbenzene, and tetramethylbenzene) from a sandy material. None of the compounds were completely removed from the material. Nonetheless, the compounds with the highest water solubility, benzene and toluene, were removed effectively; less than 1 mass % was retained with use of either the humic acid solution or water. For the less soluble organic compounds, removal was more difficult and was enhanced by the humic acid solution compared to water. Mass percent retained with humic acid was as follows: p-xylene, 1.4% (24% less than water); 3-ethyltoluene, 6.4% (40% less); sec-butylbenzene, 39% (14% less); and tetramethylbenzene, 43% (14 less). The positive effect of humic acid on the removal of these organics may arise from the aggregation of the humic acid molecules to form membranes and/or micelles, having hydrophilic exteriors and hydrophobic interiors. Partitioning of the hydrophobic organics from the bulk solution into the hydrophobic interior of these humic acid structures can account for their enhanced removal from the sandy material. (Author's abstract)
W90-07883

AVAILABILITY OF SORBED TOLUENE IN SOILS FOR BIODEGRADATION BY ACCLIMATED BACTERIA.
Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-07917

RED-LIST SUBSTANCES: SELECTION AND MONITORING.
Water Research Centre, Medmenham (England). Medmenham Lab.
A. R. Agg, and T. F. Zabel.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 44-50, February 1990. 3 fig, 3 tab, 11 ref.

Descriptors: *Monitoring, *Pollutants, *Priority pollutants, *Toxicity, *Water quality control, *Water quality standards, Bioaccumulation, Environmental quality, North Sea, Persistence, Red-list substances.

The conference of Ministers representing North Sea littoral states, held in November 1987, agreed to certain initiatives to reduce inputs of potentially dangerous substances to the North Sea from land-based sources. The UK government has responded by proposing reductions of substances on a 'red list', selected on the basis of ecotoxicity, persistence, potential for bioaccumulation, and estimated concentration in the environment. A substance is selected for the red list only after being identified as a substance having the potential to cause environmental pollution, and then being examined to establish the hazard rating and the priority for action. Controls are based on environmental quality standards, with the intention to reduce input loads by up to 50% by 1995. The workload which is required to monitor for these substances in rivers and direct inputs to tidal waters will be considerable if meaningful estimates of load reductions are to be made. Surveillance monitoring of known discharges will be an ongoing commitment to ensure compliance with discharge consents established to safeguard water quality. (Brunone-PTT)
W90-07932

RIVER BASIN MANAGEMENT: DEVELOPING THE TOOLS.
Water Research Centre, Swindon (England). Swindon Engineering Centre.
D. Fiddes, and I. T. Clifforde.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 90-97, February 1990. 3 fig, 11 ref.

Descriptors: *Sewer systems, *Water pollution control, *Watershed management, Comprehensive planning, Environmental quality, Multiobjective planning, Urban drainage.

Effective pollution control requires a detailed basin-wide appreciation of the impact of current pollution loadings on the total receiving water system, and the implications for any proposed modifications to discharge consents. The integrated approach provides greater confidence that environmental quality standards will be achieved than does the rigid adherence to uniform emission standards or 'best available technology' and will show substantial savings in capital cost of the upgrading works. A directed research program (the River Basin Management program) provides the opportunity for quality fundamental research, while ensuring that end-users have the complete set of components to build comprehensive working procedures. Active participation of the end user in the proving and refinement of the emerging technology is beneficial in speed of implementation and in ensuring optimal relevance and effectiveness of the tools. This coordinated research and implementation program bridges the gap between academic research and practical application of the findings in upgrading sewer systems. (Brunone-PTT)
W90-07937

TUALATIN RIVER: A COMMITMENT TO WATER QUALITY.
HDR Engineering, Inc., Lake Oswego, OR.
B. R. Willey.
Water Environment & Technology, Vol. 2, No. 3, p 42-47, 81, March 1990. 3 fig.

Descriptors: *Compliance, *River regulations, *Tualatin River, *Water pollution control, *Water quality management, *Water quality standards, Administrative agencies, Algal growth, Chlorophyll a, Clean Water Act, Dissolved oxygen, Ecosystems, Oregon, Oxygen sag, Phosphorus, Public relations, Rainfall, Resources management, Wildlife habitats.

Not since the historic cleanup of the Willamette has any Oregon river been subject to so much attention, concern and controversy as the Tualatin. The focus of attention is the river's green color and the resulting public perception that the river may no longer be a valuable community asset. The Washington County, Unified Sewerage Agency's (USA) treatment plants include the toughest phosphorus limits in the nation and a demanding compliance schedule. The Tualatin River is the only major water resource for Washington County. It flows in an easterly direction from the Coast Range and enters the Willamette River near West Linn. Flows in the river vary by season because it is fed by rainfall rather than snowmelt. The Tualatin is more of a wildlife refuge than a recreational river. The stream is laced with snags and fallen trees that provide habitat for fish and birds, and discourage jet skis and fast-moving motor boats. New nutrient limits would curtail the present high level of algal growth that occurs in the Tualatin each summer. Also important are dissolved oxygen sags which have been observed in the lower stretch of the river. In December, 1986, the Northwest Environmental Defense Center filed suit in federal court against EPA to require that the total maximum daily loads be promulgated for water bodies that fail to meet water-quality standards as required by Section 303 of the Clean Water Act. Because the Tualatin River was not in compliance with the target concentration for chlorophyll a, it was a primary focus for the lawsuit. The USA recognized the need to effectively integrate a wide spectrum of water quality management alternatives into a comprehensive, holistic approach with open minded consideration of all ideas. USA must build consensus on a step-by-step informed basis. A recommended management system will be developed along with an implementation plan. As a final check, this plan will again be presented to the public to ensure that USA has accurately incorporated their values. (Brunone-PTT)
W90-07951

WATER QUALITY-BASED TOXICS CONTROL.
Water Pollution Control Federation, Alexandria, VA. Toxics Control and Biomonitoring Workgroup.
Water Environment & Technology, Vol. 2, No. 3, p 48-53,80, March 1990.

Descriptors: *Administrative agencies, *Clean Water Act, *Public participation, *Toxic wastes, *Water pollution control, *Water quality standards, *Water resources management, Biodegradation, Detection limits, Dilution, Hydrolysis, Photolysis, Quality control, Regulations, Resources management, Sedimentation, Toxicity, Volatilization, Water pollution.

The Water Pollution Control Federation strongly supports the objectives of the Technical Support Document (TSD) for Water-Quality-based Toxics Control. The TSD provides much-needed guidance to regulating authorities and the regulated community on control of toxics discharge. The open manner in which the TSD was first developed, and is now being revised, with input from professionals both within and outside of the agency, is appropriate and necessary for a program with such wide-ranging interests. The TSD must contain procedures which have a sound scientific base. The development, application and enforcement of permit limits will have important impacts on most of the regulated community. The TSD should be clearly identified by title and content as a guidance document, not a regulation, and should enumerate representative alternative methodologies to ensure achievement of Clean Water Act goals, and explicitly allow time for development, implementation, and adjustment of newly developed alternative approaches to achieve the desired

results. Fate processes and bioavailability of substances contained in effluents should be accounted for rather than making simplistic assumptions of dilution, uptake and bioconcentration. Physical processes such as sedimentation and volatilization and transformations such as biodegradation, hydrolysis, and photolysis, result in substantial differences in in-stream concentrations of compounds compared with those that might be calculated through dilution. Quality assurance/quality control is one of the most important aspects of a water quality-based toxics control program, especially when regulatory decisions are based on laboratory-derived data. Confidence intervals need to be taken into account in determining pass/fail for biomonitoring tests, and the toxicity unit concept must include a recognition of limitations on the detection limit. These sorts of measures will promote improved quality control and subsequent data use throughout the country. Toxics control is a complex issue both from the side of regulation and from the side of assessment, identification, and control. For this reason, it is imperative that the EPA, thorugh the TSD, should promote a partnership between the responsible regulatory agencies and the regulated community in solving toxics control problems. (Brunone-PTT)
W90-07952

MANURE MANAGEMENT AND POLLUTION PREVENTION.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5D.
W90-07953

LYSIMETER STUDY OF THE EFFECTS OF A RYEGRASS CATCH CROP, DURING A WINTER WHEAT/MAIZE ROTATION, ON NITRATE LEACHING AND ON THE FOLLOWING CROP.
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France). Dept. de Biologie.
J. Martinez, and G. Guiraud.
Journal of Soil Science JSSCAH, Vol. 41, No. 1, p 5-16, March 1990. 3 fig, 6 tab, 32 ref.

Descriptors: *Leaching, *Lysimeters, *Nitrates, *Nonpoint pollution sources, *Ryegrass, *Water pollution control, Corn, Fertilizers, Water quality control, Wheat.

Substantial quantities of nitrate can be leached from certain cropping systems in which the soil is left bare during autumn and winter. A 'catch crop' has been proposed as a means of minimizing nitrogen losses. The effects of using Italian ryegrass as an intercrop catch crop (1) on the amounts and concentrations of nitrate leached during the autumn and winter intercrop period, and (2) on the following crop, were examined in a lysimeter experiment and compared with that from a bare fallow treatment. A calcium and potassium nitrate fertilizer labeled with 15-N (200 kg N/ha excess) was applied to the winter wheat in spring. Total N uptake by the winter wheat was 154 kg/ha and the recovery of fertilizer-derived N (labeled with 15-N) was 60%. The catch crop (grown without further addition of N) yielded 3.8 t/ha herbage dry matter, containing 43 kg N/ha, of which 4.1% was derived from the 15-N-labeled fertilizer. Two hundred kg unlabeled N/ha was applied to the maize crop. During the intercrop period the nitrate concentration in water draining from the bare fallow lysimeters reached 68 mg N/L, with an average of 40 mg N/L. With the catch crop there was a rapid decline from 41 mg N/L to 0.25 mg N/L at the end of ryegrass growth. 15-N-labeled nitrate was detected in the first drainage water collected in autumn, 5 months after the spring application. The quantity of fertilizer-N that was leached during this winter period was greater under bare fallow (18.7% of applied N) than when a catch crop was grown (7.1%). With the ryegrass catch crop incorporated at the time of seedbed preparation in spring, the subsequent maize grain-yield was lowered by an average of 13%. Total N-uptake by the maize sown following bare fallow was 224 kg N/ha, compared with 180 kg/ha with prior incorporation of ryegrass; the corresponding values for

uptake of residual labeled N were 3% (bare fallow) and 2% (ryegrass) of the initial application. (Author's abstract)
W90-07995

MAINTENANCE OF COOLING TOWERS FOLLOWING TWO OUTBREAKS OF LEGIONNAIRES' DISEASE IN A CITY.
Newcastle upon Tyne Univ. (England). Div. of Community Medicine.
For primary bibliographic entry see Field 5B.
W90-08030

LANDFILL REUSE STRATEGIES.
New York State Energy Research and Development Authority, Albany.
For primary bibliographic entry see Field 5E.
W90-08036

CONTRIBUTION OF SILVER CARP (HYPOPHTALMICHTHYS MOLITRIX) TO THE BIOLOGICAL CONTROL OF NETOFA RESERVOIRS.
Nessin Water Quality Central Lab., Nazareth (Israel).
For primary bibliographic entry see Field 2H.
W90-08071

PHOSPHORUS EUTROPHICATION RESEARCH IN THE LAKE DISTRICT OF SOUTH WESTERN FRIESLAND, THE NETHERLANDS: PRELIMINARY RESULTS OF ABIOTIC STUDIES.
Limnologisch Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
For primary bibliographic entry see Field 5C.
W90-08073

PHOSPHORUS DYNAMICS FOLLOWING RESTORATION MEASURES IN THE LOOSDRECHT LAKES (THE NETHERLANDS).
Limnologisch Inst., Nieuwersluis (Netherlands).
L. Van Liere, R. D. Gulati, F. G. Wortelboer, and E. H. R. R. Lammens.
Hydrobiologia HYDRB8, Vol. 191, p 87-95, February 28, 1990. 4 fig, 4 tab, 25 ref.

Descriptors: *Lake restoration, *Loosdrecht Lakes, *Phosphorus, *The Netherlands, *Wastewater pollution, *Water pollution control, Chlorophyll a, Crustaceans, Cycling nutrients, Lake Breukeleveen, Lake Loosdrecht, Lake Vuntus, Performance evaluation, Zooplankton.

External phosphorus loads to three shallow lakes in The Netherlands were reduced by eliminating wastewater discharge and by dephosphorization of the supply water. Concentrations of total P and chlorophyll a were reduced significantly during 1980-1986 in Lake Breukeleveen, but not in Lake Vuntus and Lake Loosdrecht. In 1983-1986 the phosphorus flow through several trophic levels was determined. Changes over these years were not significant. External input to the lakes still contributes substantially to the phosphorus input. Release from the sediments also contributed to the cycling of the phosphorus. Excretion by large crustacean zooplankters was important in phosphorus recycling, and delivered 20-30% of the daily phytoplankton phosphorus demand. A similar contribution is expected from fish. Additional measures will be needed to achieve accelerated recovery of these lakes. (Author's abstract)
W90-08074

ZOOPLANKTON STRUCTURE IN THE LOOSDRECHT LAKES IN RELATION TO TROPHIC STATUS AND RECENT RESTORATION MEASURES.
Limnologisch Inst., Nieuwersluis (Netherlands).
R. D. Gulati.
Hydrobiologia HYDRB8, Vol. 191, p 173-188, February 28, 1990. 9 fig, 5 tab, 46 ref.

Descriptors: *Lake restoration, *Limnology, *Loosdrecht Lakes, *Phosphorus removal, *The Netherlands, *Zooplankton, Crustacea, Ecosystems, Fish, Predation, Rotifers, Trophic level.

A 5-yr zooplankton study (1982-1986) on three shallow and highly eutrophic lakes in the Loosdrecht area (The Netherlands) did not reveal any significant changes following the considerable reduction in external P-loading (from about 1.0 g to 0.3 g P/sq m/yr) since 1984. The recent annual fluctuations in the rotifer and crustacean densities are within the range of those found before the restoration measures became operative. A decrease in the average size of the crustaceans and an absence of large-bodied forms reflects an increased fish predation rather than a change in the quality or the quantity of their sestonic food (< 150 micrometer), which continues to be dominated by filamentous cyanobacteria and Prochlorothrix hollandica, a prochlorophyte recently discovered in these lakes. (Author's abstract)
W90-08083

ASSESSMENT OF THE IMPORTANCE OF EMERGENT AND FLOATING-LEAVED MACROPHYTES TO TROPHIC STATUS IN THE LOOSDRECHT LAKES (THE NETHERLANDS).
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
For primary bibliographic entry see Field 2H.
W90-08090

RESTORATION BY BIOMANIPULATION IN A SMALL HYPERTROPHIC LAKE: FIRST-YEAR RESULTS.
Water Board of Utrecht (Netherlands).
E. Van Donk, R. D. Gulati, and M. P. Grimm.
Hydrobiologia HYDRB8, Vol. 191, p 285-295, February 28, 1990. 8 fig, 3 tab, 35 ref.

Descriptors: *Fish stocking, *Lake Zwemlust, *Lake restoration, *The Netherlands, Aquatic habitats, Chlorophyll a, Crustacea, Fish, Hypertrophic lakes, Nitrogen, Performance evaluation, Phosphorus, Phytoplankton, Predation, Transparency.

Biomanipulation was carried out to improve the water quality of the small hypertrophic Lake Zwemlust, The Netherlands (1.5 ha, mean depth 1.5 m). In March 1987 the lake was drained to facilitate the elimination of fish. The lake was subsequently restocked with 1500 northern pike fingerlings (Esox lucianus L.) and a low density of adult rudd (Scardinius erythrophthalmus). Stacks of Salix twigs, roots of Nuphar lutea, and plantlets of Chara globularis were installed as refuge and spawning grounds for the pike and as shelter for zooplankton. The abundance of phytoplankton in the first summer (1987) after this biomanipulation was very low, and consequently accompanied by increase of Secchi-disc transparency and drastic decline of chlorophyll a concentration. Submerged vegetation remained scarce, with only 5% of the bottom covered by macrophytes at the end of the season. Zooplankters became more abundant and there was shift from rotifers to cladocerans, comprised mainly of Daphnia and Bosmina species. The offspring of the stocked rudd were present in the lake from the end of August 1987; only 19% of the stocked pike survived the first year. Grazing pressure of the zooplankton was able to keep chlorophyll a concentrations and algal abundance at low levels, even in the presence of very high concentrations of inorganic N and P. The total nutrient level increased after biomanipulation, probably due to increased release from the sediment by bioturbation, the biomass of chironomids being high. (Author's abstract)
W90-08093

OPERATION OF THE KIS-BALATON RESERVOIR: EVALUATION OF NUTRIENT REMOVAL RATES.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
F. Szilagyi, L. Somlyody, and L. Koncsos.
Hydrobiologia HYDRB8, Vol. 191, p 297-306, February 28, 1990. 5 fig, 2 tab, 12 ref.

Descriptors: *Hungary, *Lake Balaton, *Lake restoration, *Nutrient removal, *Water pollution con-

trol, Fish, Hidveg Reservoir, Macrophytes, Nitrogen, Nutrients, Performance evaluation, Phosphorus, Phytoplankton, Zala River, Zooplankton.

As one of the major measures for controlling the man-made eutrophication of Lake Balaton (Hungary), the Hidveg Reservoir (20 sq km surface area) was built near the River Zala, draining half the watershed of the lake, and representing the largest nutrient source for the lake. The reservoir, as the first element of an expected total system of 70 sq km surface area (Kis-Balaton Control System), started to operate in June 1985, aiming at removing nutrients primarily through sedimentation, adsorption, and uptake by macrophytes. Detailed investigations with the operation of the reservoir. These cover the observation of upstream and downstream nutrient loads and the water quality in the reservoir, the study of major phosphorus removal processes, and the analysis of the N cycle and of the behavior of phytoplankton, zooplankton, fish, and macrophytes. The nutrient removal efficiencies of the reservoir came up to expectations. The removal rates for suspended solids, total-P, soluble-reactive P, and nitrate-N exceeded 50% in the first full year of operation (1986). As a result of reservoir operation, nutrient loads in the western basin of Lake Balaton have been reduced significantly. However, the improvement in water quality can be expected only with a lag time due to the internal P load of the basin. (Author's abstract)
W90-08094

REMEDIAL TECHNOLOGIES FOR LEAKING UNDERGROUND STORAGE TANKS.
Weston (Roy F.), Inc., Concord, CA.
Lewis Publishers, Inc., Chelsea, Michigan. 1988. 216p.

Descriptors: *Cleanup operations, *In situ treatment, *Site remediation, *Underground storage tanks, *Water pollution treatment, *Water quality control, Biodegradation, Containment, Economic aspects, Feasibility studies, Groundwater pollution, Isolation, Land disposal, Leaching, Soil contamination, Solidification, Stabilization, Volatilization.

The electric utility industry owns and operates many underground and aboveground storage tanks as well as other facilities for using, storing, or transferring petroleum products, primarily motor and heating fuels. The prevention, detection, and correction of leakage of these products from underground storage tanks (UST) has gained high priority in the utility industry and within the regulatory agencies. The 1984 amendments to the Resource Conservation and Recovery Act (RCRA) require the US EPA to develop new Federal regulations for reducing and controlling environmental damage from underground storage tank leakage. This report presents a summary description and evaluation of 13 remedial methods for soil and groundwater cleanup: in situ technologies--volatilization, biodegradation, leaching and chemical reaction, vitrification, passive remediation, and isolation/containment; and non-in situ technologies—land treatment, thermal treatment, asphalt incorporation, solidification/stabilization, groundwater extraction and treatment, chemical extraction, and excavation. The information in this report is organized in terms of four major considerations in evaluating the relative feasibility of each method: technical feasibility, implementation feasibility, environmental feasibility, and economic feasibility. (Lantz-PTT)
W90-08135

MANAGING INDUSTRIAL HAZARDOUS WASTE: A PRACTICAL HANDBOOK.
G. F. Lindgren.
Lewis Publishers, Inc., Chelsea, Michigan. 1989. 389p.

Descriptors: *Hazardous wastes, *Industrial wastes, *Regulations, *Waste disposal, *Waste management, Best management practices, Federal jurisdiction, Solid wastes, Water pollution prevention, Water pollution treatment.

Industrial waste management has been revolutionized by Subtitle C of the federal Resource Conser-

vation and Recovery Act of 1976 (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA). With these regulations, EPA provided a set of minimum standards for all who are involved in hazardous waste management--the generator, the transporter, and the owner/operator of treatment, storage, or disposal (TSD) facilities. The purpose of this book is to provide those responsible for waste management at manufacturing firms with: (1) a framework to understand the complex web of regulatory requirements; and (2) a philosophy to guide waste management decision making within the regulatory context. Section I provides an overview of the hazardous waste management system and outlines the regulatory definitions of solid and hazardous wastes. The three determinations necessary for potentially regulated manufacturing firms are described. These determinations are: (1) which wastes are at the facility; (2) whether any of the wastes are hazardous under existing regulatory definitions; and (3) which regulatory requirements are applicable, given the quantities of hazardous waste generated, and the types of hazardous waste management activities conducted at the facility. Section II includes an in-depth explanation of the federal regulatory standards applicable to the different categories of hazardous waste generators. Areas where state hazardous waste regulations may differ from federal requirements are identified. Section III presents a philosophical basis for a corporate compliance program and then provides guidance and describes the actions and paperwork necessary for such a program. Key factors to be considered are specified. Section IV concludes with some practical information. Topics including selecting commercial treatment/disposal vendors, considerations in waste sampling and analysis, dealing with regulatory agency officials and consultants, legal liabilities, and examples of 'best management practices.' (Lantz-PTT)
W90-08136

INDUSTRIAL WATER POLLUTION CONTROL.
Vanderbilt Univ., Nashville, TN. Dept. of Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 5D.
W90-08137

STORMWATER DETENTION FOR DRAINAGE, WATER QUALITY, AND CSO MANAGEMENT.
Malmo Water and Sewer Works (Sweden).
Prentice-Hall, Englewood Cliffs, New Jersey. 1990. 338p.

Descriptors: *Combined sewer overflows, *Controlled storage, *Storm runoff, *Storm water, *Urban runoff, *Water pollution prevention, *Water quality control, *Water storage, Computer models, Detention reservoirs, Flow regulators, Infiltration, Inlets, Model studies, Percolation, Ponds, Precipitation, Sewer systems, Storage reservoirs, Tunnels, Wastewater treatment.

Four aspects of stormwater control are covered: (1) storage facilities; (2) flow regulation; (3) estimating storage volumes; and (4) stormwater quality enhancement. The term storage facilities is used to describe any combination or arrangement of detention and retention facilities in a combined sanitary-storm sewer system or a separate stormwater conveyance system. Storage options discussed include local disposal byu infiltration and percolation; inlet control facilities; open ponds; concrete basins; storage in sewer networks; storage in pipe systems; tunnel storage; storage at sewer treatment plants, including the use of stormwater to equalize the flow or waste load to the plant. Flow regulators may be of either a fixed or movable type. Three special flow regulators discussed are: (1) Steinscrew; (2) Hydrobrake; and (3) Wirbeldrossel. The basic principles of estimating the required storage volumes are briefly considered. Precipitation data needs,and calculation methods for infiltration and percolation facilities,and for detention facilities are discussed. Several computer models for estimating storage volumes are reviewed. Stormwater pollutants, suspended solids in stormwater, sedimentation, and the design of water

quality basins for stormwater are discussed as part of an examination of the emerging technology of using stormwater detention for the removal of pollutants found in separate urban stormwater runoff. (Lantz-PTT)
W90-08138

SUBSURFACE AGRICULTURAL DRAINAGE IN CALIFORNIA'S SAN JOAQUIN VALLEY.
California State Dept. of Water Resources, Sacramento.
For primary bibliographic entry see Field 5B.
W90-08142

DRINKING WATER AND HEALTH. VOLUME 9: SELECTED ISSUES IN RISK ASSESSMENT.
National Research Council, Washington, DC. Safe Drinking Water Committee.
For primary bibliographic entry see Field 5C.
W90-08158

STANDARD HANDBOOK OF ENVIRONMENTAL ENGINEERING.
McGraw-Hill Publishing Co., New York, New York. 1990. 1282p. Edited by Robert A. Corbitt.

Descriptors: *Environmental engineering, *Handbooks, *Waste management, *Wastewater treatment, *Water pollution control, *Water quality control, Air pollution, Standards, Wastewater disposal, Water pollution sources.

For some time, the term sanitary engineering was used to describe the practice of those engineers who designed water and sewerage systems and the public health protection works. The area of practice then expanded when society recognized that protection of the air, land, and water environment is necessary for all living things. Today, the term environmental engineering has evolved to describe the engineer's increased emphasis on the biological, chemical, and physical reactions in the air, land, and water environments and on improved technology for reuse, recycle, and recovery measures. Recently, billions of public and private dollars have been devoted to the study, design, and construction of pollution control and environmental protection facilities. The Handbook is a comprehensive manual on the principle and practice of environmental engineering. Chapters are provided on the most significant technical aspects of air quality control, water supply, wastewater disposal, and solid waste management. Also, individual chapters are provided in stormwater and hazardous waste management; these two disciplines are of current notoriety and will become even more important in the years ahead. Emerging technologies are introduced and will be discussed in future editions when there is a more developed database and performance record. Similarly, less significant and/or specialized technologies are discussed only briefly. Additional chapters provide insight into historic and fundamental aspects of legislation, quality standards, and environmental assessment procedures, which broadly define objectives of environmental engineering services. (See W90-08178 thru W90-08185) (Lantz-PTT)
W90-08177

AIR AND WATER QUALITY STANDARDS.
PEER Consultants, Inc., Washington, DC.
L. A. Abron, and R. A. Corbitt.
IN: Standard Handbook of Environmental Engineering. McGraw-Hill Publishing Co., New York, New York. 1990. p 127-141, 12 tab, 12 ref.

Descriptors: *Clean Water Act, *Legislation, *Standards, *Water quality control, *Water quality standards, Air pollution, Federal jurisdiction, Public health, Regulations.

Through passage of the Clean Air Act, as amended, and the Clean Water Act, as amended, the US Congress has established national goals for air and water quality to protect public health and welfare and has required the use of quality standards, and criteria, for control of pollutants in the environment. In order to restore, maintain, and improve

the quality of the air and water environment, two approaches for setting standards have been used. One approach is to establish environmental or ambient levels, such as air quality or stream water quality, and the second approach has been to establish limits on discharges to the environment. Environmental legislative history for water pollution control contains very important discussions on the use of standards. There are two ways of establishing discharge limitations: (1) set emission or effluent limitations based on desired air quality or stream quality; or (2) apply available technology. This dual approach will eventually satisfy the goals of the Clean Air and Water acts. As is explained in this chapter, the approach in the Clean Air Act is to determine the relationships between public health and welfare and air quality while restoring, maintaining, and improving the quality of the air environment. The approach of the Clean Water Act is to move forward, based on the accomplishments that have been made and knowledge gained, to achieve the ultimate goal of clean, fishable, swimmable waters devoid of pollutants and toxicants. (See also W90-08177) (Lantz-PTT)
W90-08180

STORMWATER MANAGEMENT.
Browne (F.X.) Associates, Inc., Lansdale, PA.
For primary bibliographic entry see Field 5D.
W90-08183

HAZARDOUS WASTE.
Post, Buckley, Schuh and Jernigan, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5D.
W90-08184

GROUNDWATER CONTAMINATION AND POLLUTION IN MICRONESIA.
Societe Anonyme Francaise d'Etudes, de Gestion, et d'Enterprise, Nanterre (France).
For primary bibliographic entry see Field 5B.
W90-08223

WATER QUALITY MANAGEMENT IN THE RSA: PREPARING FOR THE FUTURE.
Department of Water Affairs, Pretoria (South Africa).
W. van der Merwe, and D. C. Grobler.
Water SA WASADV, Vol. 16, No. 1, p 49-53, January 1990. 8 ref.

Descriptors: *Environmental policy, *Future planning, *Water pollution control, *Water quality management, *Water quality standards, Economic aspects, Hazardous wastes, Nonpoint pollution sources, Social aspects, South Africa, Uniform flow, Water pollution prevention, Water quality trends.

The uniform effluent standard approach is presently used in the Republic of South Africa (RSA) to control pollution from point sources. Water quality in the RSA is gradually deteriorating and social and economical changes taking place affect water quality and the way in which it is managed. A new approach, which combines the receiving water quality objectives and pollution prevention approaches, will be used in the future to control pollution from both point and nonpoint sources. The receiving water quality objectives approach to control input of non-hazardous pollutants and the pollution prevention approach to control input of dangerous or hazardous substances to the water environment will be used. (Author's abstract)
W90-08231

FIELD RESEARCH ON ALDICARB MANAGEMENT PRACTICES FOR UPSTATE NEW YORK.
New York State Water Resources Research Inst., Ithaca.
K. S. Porter, R. J. Wagenet, R. L. Jones, and T. E. Marquardt.
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 3, p 279-287, 1990. 4 tab, 13 ref.

Descriptors: *Agricultural chemicals, *Aldicarb, *Carbamate pesticides, *Groundwater pollution, *Water pollution control, Biodegradation, Field tests, New York, Path of pollutants, Pesticide residues, Potatoes, Soil pollution, Test wells, Water pollution sources.

In 1979, aldicarb residues were detected in drinking water wells on Long Island. The need to develop aldicarb management practices in upstate New York potato fields, which would continue the benefits associated with the pesticide while protecting drinking water wells, led to a three-part research program conducted in 1983: samples from 57 wells and three test holes were collected near potato fields in six counties; aldicarb residues were monitored in water from a tile-drained field near Willsboro; and a study of aldicarb residues in the unsaturated zone was conducted in a potato field near Phelps. Results show that aldicarb residues from applications made in June degrade with a half-life of about one month in surface soils. The persistence and transport of aldicarb residues from these later applications is shown to be less compared to the usual previous practice of applying aldicarb at planting. The potable well sampling indicated that where applications are made at the usual planting time in midspring, aldicarb residues may appear in drinking water wells located very near the treated fields. The results of this and other related studies confirm the soundness of later applications of aldicarb when the soils are warmer and when there is less soil water percolation. This practice is embodied in the current North Eastern regulations, which require application of aldicarb at plant emergence and prohibit applications within 150 m of drinking water wells. (Author's abstract)
W90-08241

CHARACTERIZATION OF THE REDUCING PROPERTIES OF ANAEROBIC SEDIMENT SLURRIES USING REDOX INDICATORS.
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5B.
W90-08242

RISK EQUIVALENT SEASONAL DISCHARGE PROGRAMS FOR MULTIDISCHARGER STREAMS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
B. J. Lence, J. W. Eheart, and E. D. Brill.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 170-186, March/April 1990. 4 fig, 2 tab, 18 ref.

Descriptors: *Flow rates, *River basins, *Seasonal variation, *Wastewater disposal, *Water pollution control, *Water quality management, Biochemical oxygen demand, Effluents, Multidischarger streams.

Water quality management programs that allow different waste discharge rates during different seasons of the year are an innovative approach for reducing the cost of waste treatment. An approach for designing such seasonal waste discharge programs in river basins with several different dischargers was presented. This approach was illustrated for the control of biochemical oxygen demand (BOD). The risk of water quality violation was defined as the probability of incurring one or more water quality violations in any given year, and the seasonal waste effluent rates of the dischargers were designed to maintain a specified level of risk while minimizing the total waste treatment effort of the dischargers. Two seasonal waste discharge programs were proposed as surrogates for minimizing waste treatment effort, the minimum average uniform treatment program and the maximum total discharge program. Simulations of these programs suggest that either seasonal discharge program would significantly reduce waste treatment costs relative to a nonseasonal program. Furthermore, comparison of costs of seasonal waste discharge programs indicates that for the example river basin, a seasonal uniform treatment program may be implemented that is potentially more acceptable to the dischargers and is less costly than a seasonal maximum total discharge program. (Author's abstract)

W90-08273

PRINCIPLES AND PROBLEMS OF ENVIRONMENTAL POLLUTION OF GROUNDWATER RESOURCES WITH CASE EXAMPLES FROM DEVELOPING COUNTRIES.
Anambra State Univ. of Technology, Enugu (Nigeria). Dept. of Geological Sciences.
For primary bibliographic entry see Field 5B.
W90-08298

INFLUENCE OF LIME AND BIOLOGICAL ACTIVITY ON SEDIMENT PH, REDOX AND PHOSPHOROUS DYNAMICS.
Bergen Univ. (Norway). Zoological Museum.
T. Smayda.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 191-203, March 15, 1990. 5 fig, 44 ref.

Descriptors: *Acid rain, *Ecological effects, *Hydrogen ion concentration, *Lake restoration, *Lime, *Water pollution treatment, Chemical interactions, Lake Hovvatn, Lake sediments, Oxidation-reduction potential, Phosphorus.

The addition of powdered limestone to intact sediment cores from oligotrophic, acid Lake Hovvatn caused pH to increase, redox potential to drop, and permitted net precipitation of phosphorous (P) from the water column. Significant pH increase was found to a sediment depth of 6 cm and a maximum increase in pH from 4.9 to 6.5 was found at a depth of 0.5 cm when dosed with 36 g/sq m of lime. This pH increase creates important changes in sediment equilibrium chemistry and enhances habitat suitability. In the case of Hovvatn, however, sediments would consume only 5 kg of the 91 tons of applied limestone. Superficial sediments remained oxidized, but below 0.5 cm, redox potential in limed sediment declined significantly more than in unlimed sediments, with a maximum difference of 102 millivolts versus -66 millivolts at a depth of 6 cm in unlimed and limed cores. Abiotic reactions account for $82 +/-54\%$ of this reduction and the remainder is due to the oxidation of organic matter by bacteria. Precipitation of $CaSO4$, reduction of the sediments by organic compounds at elevated pH and inhibition of the downward diffusion of $O2$ by the limestone powder are potential abiotic mechanisms which could drive redox potential down. Enhanced P release was not found at lowered redox potential, and supernatent total phosphorous concentrations dropped from 11.7 to 4.4 microgm/L. More P was swept from solution in cores which received larger lime doses. The presence of chironomids caused sediment pH to increase by as much as 1.2 pH units, presumably due to $NH4$ release, reduced sediment redox potential by as much as 171 millivolts and facilitated total phosphorous release during the first 17 d of core incubation. Field measurements of vertical distributions of sediment pH and redox potential before and after the liming of Hovvatn corroborated laboratory findings. (Author's abstract)
W90-08312

FACTORS INFLUENCING PHOSPHATE EXCHANGE ACROSS THE SEDIMENT-WATER INTERFACE OF EUTROPHIC RESERVOIRS.
Essex Univ., Colchester (England). Dept. of Biology.
C. J. Redshaw, C. F. Mason, C. R. Hayes, and R. D. Roberts.
Hydrobiologia HYDRB8, Vol. 192, No. 2/3, p 233-245, March 15, 1990. 7 fig, 4 tab, 33 ref.

Descriptors: *Eutrophic lakes, *Eutrophication, *Lake restoration, *Phosphates, *Reservoirs, *Sediment-water interfaces, Adsorption, Ardleigh Reservoir, Dissolved oxygen, England, Hydrogen ion concentration, Phosphorus, Temperature, Water quality.

The results of a survey of the sediment chemistry of 7 East Anglian reservoirs are presented as part of a regional study on the assessment and control of eutrophication. The influence of water quality (dissolved oxygen, pH, temperature) on phosphate (PO4) adsorption by sediment from hypertrophic

Ardleigh Reservoir is also examined. Extractable phosphate-P (extr.-P) varied between 92 and 383 mg/kg dry matter. Extractable P varied between 5.3 and 16.6% of the total phosphate-P (Tot.P) content and increased with the concentration of dissolved reactive phosphate-P in the overlying water column. Organically complexed iron (organic Fe) was the determinand which correlated most closely with phosphate adsorption capacity, PAC (r = 0.8). Organic Fe was also related inversely to Extr. P. The rate and extent of PO4 adsorption by Ardleigh Reservoir sediment increased with the initial concentration of dissolved reactive phosphate-P and adsorption equilibria were reached after 24 h. The equilibrium dissolved reactive phosphate-P concentration was 0.7 mg P/L under aerobic conditions indicative of a high potential for PO4 exchange. The rate and extent of PO4 adsorption was greater at 7 C than at 22 C. PO4 adsorption increased markedly with dissolved oxygen status. Ardleigh sediment exhibited a marked buffering capacity to a change in pH; however, PO4 adsorption was greatest at an equilibrium pH of 5.6 and decreased progressively either side of this pH value. (Author's abstract)
W90-08316

MONITORING SYSTEMS FOR WATER QUALITY.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
R. C. Ward, and J. C. Loftis.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 19, No. 2, p 101-118, 1989. 3 fig, 54 ref.

Descriptors: *Automation, *Information systems, *Monitoring, *Water pollution control, *Water quality management, Design criteria, Literature review, Network design, Sampling, Statistical methods, Water quality control.

The information needs of water quality management programs of today are often being placed on monitoring systems designed and implemented years ago for water pollution control programs. Water quality monitoring system design can be placed in a framework that permits a more organized and systematic approach to the tasks involved, wherein emphasis is placed on the need to specify the information sought along with identifying appropriate statistical methodologies. The need to routinely report information is necessary as a means to insure that the information expectations are met. Consistent day-to-day operating procedures are required to insure that the data represent water quality variability rather than sampling variability. Whenever a 'framework' for design is presented, there is a tendency to conclude that the design of such systems has reached a point where everything can be specified concretely. The need exists to approach monitoring system design systematically and yet maintain flexibility in design as well as implementation. The framework presents the tasks required in one overall view. Hopefully, this attempt to quantify and organize the design process will generate a dialog that should improve future efforts to design and operate water quality monitoring systems. (Fish-PTT)
W90-08320

AUTOMATED CALIBRATION AND USE OF STREAM-QUALITY SIMULATION MODEL.
CH2M Hill, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5B.
W90-08341

HYDRAULIC DESIGN OF WINTER LAKE AERATION SYSTEM.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
C. R. Ellis, and H. G. Stefan.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 376-393, March/April 1990. 12 fig, 1 tab, 28 ref.

Descriptors: *Aeration, *Environmental engineering, *Eutrophic lakes, *Hydraulic design, *Lake restoration, *Oxygenation, Diffusers, Fish conservation, Fishkill, Ice cover, Oxygen demand, Thermal stratification, Thermocline.

Shallow, eutrophic lakes in the upper Midwest of the United States are subject to fish mortality due to oxygen depletion under ice (winterkill). Current practices employed to prevent this phenomenon typically create an area of open water, which poses a hazard to winter lake users. An aeration system has been designed and hydraulically modeled that: (1) will maintain oxygen concentrations adequate for fish survival while minimizing oxygen consumption; and (2) will not destroy or weaken the ice cover. This system consists of back-to-back manifolds, each incorporating a flow diffuser, that withdraw water from a layer within the naturally-occurring winter thermocline and return it after aeration to this same layer. This is done at very low velocity with a minimum of vertical entrainment or mixing. Between withdrawal and reinsertion, the water is aerated by conventional means, e.g., free overfall or cascading aeration. Since a stable density stratification is maintained, warm water from the bottom is prevented from moving to the surface where ice melting would occur, and oxygenated water is separated from the sediment where most of the winter oxygen demand resides. (Author's abstract)
W90-08350

EFFECTS OF DECREASING HEAVY METAL CONCENTRATIONS ON THE BIOTA OF BUTTLE LAKE, VANCOUVER ISLAND, BRITISH COLUMBIA.
Ministry of Environment, Nanaimo (British Columbia). Waste Management Branch.
J. Deniseger, L. J. Erickson, A. Austin, M. Roch, and M. J. R. Clark.
Water Research WATRAG, Vol. 24, No. 4, p 403-416, April 1990. 10 fig, 1 tab, 29 ref.

Descriptors: *Bioaccumulation, *Canada, *Heavy metals, *Lake restoration, *Lakes, *Mine wastes, *Pollutant load, *Water pollution control, *Water pollution effects, Bioindicators, Buttle Lake, Data acquisition, Phytoplankton, Salmon, Species diversity, Trout, Zooplankton.

Since 1966, a copper-lead-zinc mine operated by Westmin Resources Limited has been a source of heavy metal input into Buttle Lake, British Columbia. Metal levels increased in the lake, peaking in 1980/1981; thereafter, improved treatment and collection systems at the mine site have resulted in steadily decreasing metal levels throughout the lake system. The increase in metal concentrations in the lake water was accompanied by increased metal concentrations in salmonid muscle and liver tissues, by elevated levels of hepatic metallothionein and by declines in both species diversity and population for phytoplankton, periphyton and zooplankton. However, recovery of the biota of Buttle Lake with a decrease in metal concentrations has not followed a simple reversal of the earlier trends. While metal levels in rainbow trout muscle tissue have improved significantly, copper and cadmium liver tissue levels remain significantly higher than for the control lakes. Hepatic metallothionein levels in rainbow trout have declined steadily from a maximum of 269 plus or minus 23 nmol/g in 1981 to a low of 64 plus or minus 22 nmol/g in 1985, which is similar to a control lake. Interspecies comparison of muscle and liver tissue levels both for Buttle Lake and for uncontaminated British Columbia lakes found that rainbow trout, cutthroat trout, and Dolly Varden char respond differently to metals in the environment. It is apparent that trends in rainbow trout data should not be generalized to include all three groups. As metal concentrations decreased, the phytoplankton community began to change so that beginning in 1983 and continuing well into 1985, a continuous phytoplankton bloom consisting of a viral monoculture of Rhizosolenia eriensis was present throughout the lake. Accompanying the bloom was a scarcity of zooplankton. However, as levels of R. eriensis peaked in 1985, zooplankton and phytoplankton diversity and species number are improving as previously dominant species begin to reappear. (Author's abstract)
W90-08381

WHOLE-LAKE AND NEARSHORE WATER CHEMISTRY IN BOWLAND LAKE, BEFORE AND AFTER TREATMENT WITH CACO3.
B.A.R. Environmental, Guelph (Ontario).
L. A. Molot, P. J. Dillon, and G. M. Booth.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 412-421, February 1990. 7 fig, 4 tab, 52 ref.

Descriptors: *Acid rain, *Acidic water, *Bowland Lake, *Calcium carbonate, *Lake restoration, *Neutralization, *Water chemistry, *Water quality, Alkalinity, Aluminum, Calcite, Canada, Dissolved organic carbon, Groundwater recharge, Hydrogen ion concentration, Lake management, Manganese, Oligotrophic lakes, Ontario, Runoff, Snowmelt, Surface-groundwater relations, Transparency.

After neutralization of Bowland Lake, a clear oligotrophic acidified lake, with CaCO3, in August 1983, the whole-lake pH and alkalinity increased from 4.9 and -6 microequivalents/L to 6.7 and 89 microequivalents/L, respectively. Total whole-lake Al decreased gradually from 130 to 30 micrograms/L, Mn decreased from 80 to 28 micrograms/L and the lake became less transparent as dissolved organic carbon increased and Secchi depth decreased. Metals other than Al and Mn remained low and did not respond to neutralization. Between August 1983 and March 1986, about 40% of the added alkalinity of Bowland Lake was lost. Decreases of whole-lake pH following snowmelt occurred prior to but not after neutralization. Neutralization of lake water did not prevent acidic melt water from forming a distinctive acidic zone <1 m thick beneath the ice. The melt layer was more acidic than lake water, it was colder and therefore less dense, it usually contained higher Al, and it was dilute with lower conductivity and Ca. Intra-site variation was probably due to variable volumes of melt water received. A snowmelt model based on daily air temperature and precipitation predicted intermittent recharge of groundwater reservoirs during snowmelt. However, runoff was continually observed nearshore under ice suggesting that groundwater reservoirs continued to discharge after recharge ended or that the residence time of melt waters in the littoral zone was relatively long. (Author's abstract)
W90-08439

RESPONSE OF PHYTOPLANKTON IN ACIDIC LAKES IN ONTARIO TO WHOLE-LAKE NEUTRALIZATION.
B.A.R. Environmental, Guelph (Ontario).
L. A. Molot, L. Heintsch, and K. H. Nicholls.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 422-431, February 1990. 4 fig, 8 tab, 41 ref.

Descriptors: *Acid lakes, *Acid rain, *Ecological effects, *Fish stocking, *Lake management, *Lake restoration, *Neutralization, *Phytoplankton, *Trout, Algae, Bowland Lake, Canada, Chlorophyll a, Cyanophyta, Ecosystems, Limnology, Miskokway Lake, Ontario, Population dynamics, Species diversity, Trout Lake.

Changes in phytoplankton community composition were examined in two acidic lakes in Ontario, Bowland and Trout Lakes, to determine whether neutralization (and subsequent stocking with lake trout (Salvelinus namaycush) in the case of Bowland Lake) would reverse acidic characteristics. Miskokway Lake was monitored as an untreated reference lake. Analysis of community percentage similarity showed that year-to-year variability in phytoplankton community structure would have been low in the absence of neutralization. While changes in phytoplankton biovolumes or chlorophyll a concentrations after neutralization were not significant, there were several taxonomic changes: the shift in the Bowland Lake phytoplankton community away from dominance by the cyanophyte, Rhabdoderma, and the dominance of the pymnesiophyte Chrysochromulina breviturrita in the Bowland Lake phytoplankton community in 1985 2 years after neutralization. It is likely that the major phytoplankton taxonomic changes were direct responses to chemical changes. These results suggest that structural changes (taxonomic) maintained stability of the phytoplankton communities

under chemical stress (in terms of standing crop). (Author's abstract)
W90-08440

EFFECTS OF NEUTRALIZATION AND EARLY REACIDIFICATION ON FILAMENTOUS ALGAE AND MACROPHYTES IN BOWLAND LAKE.
Ontario Ministry of the Environment, Rexdale. Aquatic Biology Section.
M. B. Jackson, E. M. Vandermeer, N. Lester, J. A. Booth, and L. Molot.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 432-439, February 1990. 2 fig, 2 tab, 44 ref.

Descriptors: *Acid lakes, *Acid rain, *Acidification, *Algal growth, *Bowland Lake, *Hydrogen ion concentration, *Lake management, *Lake restoration, *Macrophytes, *Neutralization, *Recolonization, Algae, Alkalinity, Canada, Limnology, Ontario, Population dynamics, Species diversity, Transparency.

Within one year of neutralizing Bowland Lake (pH 4.8-5.5 increased to 6.3-6.7), previously extensive growths of filamentous algae (Mougeotia and Zygogonium, >10 and 100% shoreline coverage were essentially eliminated (<1% shoreline coverage). Reacidification in the second year (pH 5.7-6.7) was accompanied by increased submerged epilithic and epiphytic growths of predominantly Zygogonium, often to preliming coverage. As found in other studies, pH > or = 6.0 appears to represent a threshold relative to the predominance of certain filamentous algae in softwater lakes. The short time between the change in acidity and the disappearance and reappearance of the filamentous algae suggests that they may be important biological indicators or predictors of acidification and its reversal. The changes in pH and alkalinity following neutralization did not substantially affect the macrophyte community in Bowland Lake. Macrophytes were restricted primarily to littoral areas < 3 m in depth, despite excellent water transparency both before (SD=8.0 m, 1982) and after neutralization (SD= 4.5, 1985). Two uncommon species observed prior to neutralization (Eleocharis parvula and E. acicularis) were not observed afterwards, while two new and uncommon species (Nitella sp. and Brasenea schreberi) were. (Author's abstract)
W90-08441

CHANGES IN THE ZOOBENTHOS COMMUNITY OF ACIDIFIED BOWLAND LAKE AFTER WHOLE-LAKE NEUTRALIZATION AND LAKE TROUT (SALVELINUS NAMAYCUSH) REINTRODUCTION.
Ontario Ministry of the Environment, Sudbury.
W. Keller, L. A. Molot, R. W. Griffiths, and N. D. Yan.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 440-445, February 1990. 2 fig, 2 tab, 27 ref.

Descriptors: *Acid lakes, *Acid rain, *Bowland Lake, *Fish stocking, *Lake fisheries, *Lake management, *Lake restoration, *Neutralization, *Recolonization, *Trout, Benthic fauna, Canada, Hydrogen ion concentration, Invertebrates, Oligochaetes, Ontario, Population density, Species diversity.

The zoobenthos of Bowland Lake is described prior to, and for 2 yr after, neutralization of the lake from pH 4.9 to >6.0, and reintroduction of lake trout (Salvelinus namaycush). Observed changes in the total abundance, biomass, and size structure of shallow and profundal zoobenthos assemblages were attributable to changes in the fish community, not to improvements in water quality. A shift toward increased importance of oligochaetes, more representative of nonacidic conditions, occurred. However, many common, acid-sensitive taxa of zoobenthos which were absent prior to neutralization had not appeared within 2 yr after treatment, indicating insufficient time for recolonization. (Author's abstract)
W90-08442

SURVIVAL, GROWTH, AND REPRODUCTION OF LAKE TROUT (SALVELINUS NAMAYCUSH) AND YELLOW PERCH (PERCA FLAVESCENS) AFTER NEUTRALIZATION OF AN ACIDIC LAKE NEAR SUDBURY, ONTARIO.
Ontario Ministry of Natural Resources, Toronto. Fisheries Branch.
J. M. Gunn, J. G. Hamilton, G. M. Booth, C. D. Wren, and G. L. Beggs.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 47, No. 2, p 446-453, February 1990. 8 fig, 3 tab, 35 ref.

Descriptors: *Acid lakes, *Acid rain, *Lake fisheries, *Lake restoration, *Neutralization, *Perch, *Recolonization, *Trout, Bowland Lake, Calcite, Canada, Fish growth, Fish stocking, Hydrogen ion concentration, Lake management, Mortality, Ontario, Population dynamics.

Bowland Lake, an acidified lake (pH 4.8-5.2), was treated with calcite (CaCO3) in 1983. Neutralization allowed for successful reproduction by reintroduced lake trout (Salvelinus namaycush). Mortality of lake trout embryos and juveniles in field toxicity tests decreased from 52-99% preneutralization to 0-30% postneutralization. The resident yellow perch (Perca flavescens) appeared unaffected by the chemical treatment. Both interspecific and intraspecific competition were evident in the growth and body condition of perch and stocked lake trout in the years after neutralization. Springtime acid episodes continued to occur in the nearshore areas after the lake was neutralized, but no adverse effects on fish species were detected. (Author's abstract)
W90-08443

LIMNOLOGICAL CRITERIA FOR THE REHABILITATION OF A COASTAL MARSH. THE ALBUFERA OF MAJORCA, BALEARIC ISLANDS.
Universitat de les Illes Balears, Palma de Mallorca (Spain). Dept. de Biologia y Ciencias de Salud.
For primary bibliographic entry see Field 2L.
W90-08446

CLEANING THE RIVER GANGA: RHETORIC AND REALITY.
Cambridge Univ. (England). Faculty of Social and Political Science.
S. Ahmed.
AMBIO AMBOCX, Vol. 19, No. 1, p 42-45, 1989. 2 fig, 17 ref.

Descriptors: *Ganges River, *India, *Wastewater management, *Water pollution control, *Water quality control, Management planning, Pollutant identification, Public participation, Waste disposal.

In India nearly 70% of the available water is polluted and waterborne diseases such as cholera and typhoid account for 80% of all health problems in early 1985, the Indian government launched the Ganga Action Plan (GAP), its first major attempt to systematically control and monitor the pollution of this significant river. The Ganga drains 26% of the country's land area and carries a quarter of its total water resources. The total catchment area covers eight states, accounting for almost 43% of the irrigated area of India. In addition to its importance in physical and economic terms, the River Ganga is of immense religious and symbolic value to the millions of Hindus who bathe in it and use its water for ritual and drinking purposes, and who ultimately choose it as the receptacle for their ashes, partially cremated, or unburnt bodies. Over the years, population growth, urbanization, agricultural practices, and industrialization, coupled with the lack of efficient or adequate sewage treatment and waste disposal systems have all contributed to the contamination of the Ganga making its untreated waters extremely dangerous for direct use. The aim of GAP is to install or renovate sewage-pumping stations and treatment plants, provide low-cost sanitation facilities, and establish sewerage networks where necessary. Experts maintain that preventing urban sewage from flowing directly into the Ganga would cut pollution levels by 75%. While work

has begun on some of these schemes, the majority have been delayed due to bureaucratic red-tape and the constant switching of tenders from foreign companies to local ones. While it may be possible to prevent pollution (through the application of technology or controls) it is difficult to alter the attitude and consciousness of the people in regard to their relationship with the Ganga. A far-reaching public education program will be necessary to change the present situation. Two public education groups that have emerged are the Sankat Mochan Foundation and the Swatcha Ganga Abhiyan (the Clean Ganga Campaign). (Agostine-PTT)
W90-08449

RIVER WATER QUALITY: LOOKING INTO THE FOURTH DIMENSION.
For primary bibliographic entry see Field 7A.
W90-08468

STATUTORY AND REGULATORY BASIS FOR CONTROL OF VOLATILE ORGANIC CHEMICALS IN DRINKING WATER.
Environmental Protection Agency, Washington, DC. Div. of Water Supply.
A. Havinga, and J. A. Cotruvo.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 3-13, 1 fig, 3 tab, 11 ref.

Descriptors: *Drinking water, *Regulations, *Volatile organic compounds, *Water treatment, Bacteria, Copper, Federal jurisdiction, Lead, Legislation, Organic compounds, Pesticides, Safe Drinking Water Act, State jurisdiction, Trihalomethanes, Turbidity, Water quality control.

The passage of the Safe Drinking Water Act in 1974 resulted from public concerns of chemical contamination of drinking water sources and inadequate controls to address these concerns. The act was the culmination of a 4-year effort to develop a drinking water program at the national level. The 1974 act required the administrator of the EPA to establish minimum national standards for controlling the presence of contaminants in drinking water. The 1974 law established a federal/state partnership. The federal government was to establish the minimum national standards relating to the establishment of maximum contaminant levels, monitoring (including sampling and analytical) requirements, and reporting. States can apply to EPA for primary enforcement responsibility directly after meeting certain minimum programmatic standards established by EPA. The National Primary Drinking Water Regulations affect approximately 58,500 community (or residential) drinking water systems. In addition, EPA will extend the national primary drinking water regulations (as amended) to an estimated 20,000 nontransient noncommunity water systems (NTNCWS) serving factories and schools. Another 120,000 noncommunity water systems are partially covered. Currently, EPA regulates 10 inorganics, 6 pesticides, bacteriological contaminants (coliforms, viruses, Legionella, Giardia lamblia, heterotrophic plate count), turbidity, 4 trihalomethanes, and 8 other volatile synthetic organic chemicals. Regulations expanding the scope of the agency's regulatory agenda are currently proposed for lead and copper, and a proposal to regulate an additional 38 contaminants (12 VOCs, 8 inorganics, and 18 other synthetic organic compounds) was proposed for public comment in May 1989. (See also W90-08509) (Lantz-PTT)
W90-08510

MANAGEMENT CONTROLS OF VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER PROTECTION.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
M. Mlay.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 15-36, 3 fig, 3 tab, 15 ref.

Group 5G—Water Quality Control

Descriptors: *Groundwater quality, *Regulations, *Volatile organic compounds, *Water pollution control, *Water pollution sources, *Water quality management, Drinking water, Federal jurisdiction, Standards, State jurisdiction.

Groundwater supplies one-fourth of all fresh water used in the United States and is the source of drinking water for 50% of all citizens and 97% of the rural population. Twenty percent of all public drinking water systems and 29% of those in municipal areas show at least trace levels of volatile organic compounds (VOCs). While toxic chemicals are the contaminants of major national concern, there are many types of contaminants that also are important, including natural, microbiological, and other conventional pollutants. In 1984, the Office of Technology Assessment (OTA) listed 175 organic chemicals, more than 50 inorganic chemicals, and a variety of biological organisms and radionuclides that have been found in groundwater throughout the nation. The sources of contamination are many and varied. The highly publicized waste sites are not the main sources; nonwaste practices may, in fact, account for up to two-thirds of the groundwater contamination. The states have traditionally had primary authority over groundwater quality and its allocation and use. Over the past 10 years, however, the federal government has begun to take a greater role in the protection of groundwater quality. A complex network of federal, state, and local agencies engages in many activities designed to protect groundwater quality. Eleven separate federal agencies, and often multiple offices within these agencies, have some jurisdiction over groundwater. The types of controls now in use or under consideration include standard setting, source controls, product controls (e.g. chemicals and pesticides that can leach into groundwater), and land use controls. At the state level, there has been diverse but not widespread activity in setting groundwater quality goals and standards. This activity generally has taken four forms: establishing narrative groundwater standards, adapting state surface water quality criteria and/or standards to groundwater, adopting federal drinking water standards, and adopting drinking water standards for contaminants not yet covered by federal regulations. (See also W90-08509) (Lantz-PTT)
W90-08511

TOXICOLOGICAL APPROACHES FOR DEVELOPING DRINKING WATER REGULATIONS AND HEALTH ADVISORIES FOR VOLATILE ORGANIC CHEMICALS.
Environmental Protection Agency, Washington, DC. Criteria and Standards Div.
For primary bibliographic entry see Field 5F.
W90-08530

SUPERFUND RECORD OF DECISION: FLOWOOD, MS.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-196711.
Price codes: A04 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R04-88/041, September 1988. 41p, 10 fig, 5 tab, append.

Descriptors: *Cleanup operations, *Mississippi, *Superfund, *Wetlands, Capping, Costs, Estimated costs, Excavation, Groundwater pollution, Hazardous wastes, Industrial wastes, Lead, Monitoring, Pearl River, Rankin County, Sediment contamination, Solidification.

The Flowood site consists of 225 acres of mostly wetlands and lowlands, is located in the Town of Flowood, Rankin County, Mississippi, on the east side of the Pearl River. The site includes wastewater discharge areas and downstream areas adjacent to two industrial manufacturing facilities. Two manufacturing facilities have been owned and operated by a series of companies at the Flowood site since the 1950s. The northernmost facility manufactured corrugated boxes, and the southernmost facility produced ceramic tiles through the 1970s and stoneware cooking pots from the mid-1970s to the present. A routine industrial

wastewater inspection conducted by the Mississippi Department of Natural Resources (MDNR) in the fall of 1982 revealed the unpermitted discharge of hazardous substances to the onsite canal. The MDNR began an emergency treatment and removal process to address the contaminated wastewater, but discontinued the process when higher levels of lead were found in the canal adjacent to one of the manufacturing sites. In 1983, EPA investigations revealed high lead levels in onsite sludges, sediments, and surface soil. The primary contaminant affecting the soil and sediments is lead. The selected remedial action for this site include: excavation and stabilization/solidification through chemical fixation of approximately 6,000 cu yd of soil and sediments from all contaminated areas, followed by placement of the treated material in the excavated slough/lagoon area, capping with clean top soil and seeding to provide a vegetative cover; and groundwater monitoring. The estimated present worth cost of this remedial action is $2,000,000 with a first year operating and maintenance cost of $25,000. (Author's abstract)
W90-08555

SUPERFUND RECORD OF DECISION: ROSE DISPOSAL PIT, MA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-196778.
Price codes: A06 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R01-88/028, September 1988. 98p, 3 fig, 8 tab, 6 append.

Descriptors: *Cleanup operations, *Landfills, *Massachusetts, *Oil pollution, *Superfund, *Water pollution control, Adsorption, Air stripping, Aquifers, Benzenes, Chlorinated hydrocarbons, Costs, Estimated costs, Excavation, Groundwater pollution, Incineration, Lanesborough, Organic compounds, Polychlorinated biphenyls, Solvents, Toluene, Xylenes.

The Rose Disposal Pit site occupies 1.5 acres in the northern section of a 14-acre residential lot located in Lanesborough, Massachusetts, approximately 4 miles north of Pittsfield. A small man-made pond is located approximately 200 ft south of the disposal area. During the 1950s and possibly later, the General Electric Company disposed of waste oils and solvents in a trench on the site, now referred to as the disposal area. Field investigations conducted between 1981 and 1986 revealed high concentrations of polychlorinated biphenyls (PCBs) in surface and subsurface soils and indicated the presence of volatile organic compounds (VOCs) in groundwater. The volume of contaminated soil to be remediated is approximately 15,000 cu yd. The primary contaminants of concern affecting the soil, sediments, groundwater, and surface water are VOCs including toluene, xylenes, and other organics including PCBs. The selected remedial action for this site includes: excavation and onsite incineration of approximately 15,000 cu yd of contaminated soil and sediment with residue disposal onsite; groundwater pump and treatment onsite using air stripping and carbon adsorption with discharge to the aquifer; installation of a bedrock well to prohibit groundwater migration; treatment of pond sediments and surface water and subsequent restoration of the onsite pond to its original wetlands character; implementation of institutional controls; and groundwater monitoring. The estimated present worth cost for this remedial action is $6,450,000 with estimated present worth operation and maintenance of $5,790,000. (Author's abstract)
W90-08556

NEED TO UPDATE GROUND WATER POLLUTION CONTROL STRATEGIES--A TECHNICAL BASIS AND HISTORICAL PERSPECTIVE.
Battelle Pacific Northwest Labs., Richland, WA.
R. W. Nelson.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-009381.
Price codes: A03 in paper copy, A01 in microfiche.
Report No. PNL-SA--15870, December 1988. 42p, 62 ref, append. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Groundwater pollution, *Groundwater quality, *Literature review, *Water quality control, *Water quality management, Management planning, Path of pollutants, Water pollution sources.

The last half century of technical literature in groundwater quality hydrology provides a historical perspective for better evaluation of today's subsurface contamination problems. The literature emphasizes the three interrelated variables are required to evaluate the environmental consequences of any groundwater contamination problem: (1) the contaminant quantities of concentration reaching the accessible environment; (2) the arrival times of the contaminants at the accessible biosphere; and (3) the outflow locations of the contaminants to the biosphere. Each of these three variables must be known for a particular problem in order to evaluate the long-term environmental consequences of that specific problem. Today's groundwater quality regulations or control strategies consider one or perhaps two of these variables individually. Seldom, if ever, are all three considered, and regulatory emphasis on their basic functional interdependence is essentially nonexistent. Such omissions in control standards are unacceptable because they lead to unsound groundwater quality control decisions that are wasteful, unnecessarily expensive, time-consuming, and even environmentally dangerous. (Author's abstract)
W90-08560

HYDROCHEMICAL MONITORING AND HYDROGEOLOGIC CHARACTERIZATION: CONFLICT AND RESOLUTION.
Battelle Pacific Northwest Labs., Richland, WA.
R. Schalla, S. P. Luttrell, and R. M. Smith.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-009164.
Price codes: A03 in paper copy, A01 in microfiche.
Report No. PNL-SA--16306, March 1989. 13p, 2 fig, 17 ref. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Monitoring, *Regulations, *Resource Conservation and Recovery Act, *Water pollution control, *Water quality control, Aquifers, Groundwater pollution, Legislation, Path of pollutants.

This paper focuses on the conflicts that are inherent to the federal regulations of the Resource Conservation and Recovery Act (RCRA) as codified in the Code of Federal Regulations and the Technical Enforcement Guidance Document. The conflicts addressed here result from the conflicting goals of: (1) obtaining adequate information to determine the concentration and distribution of contaminants; and (2) obtaining adequate information about the hydrologic properties of the aquifers through which the contaminants are transported. Complete geohydrologic characterization, which includes determination of aquifer properties, is necessary before the rate and extent of contaminant migration can be accurately predicted. The geohydrologist usually must convince representatives of regulatory agencies and waste site owners of the need to define aquifer properties early in the characterization process. Methods available to determine aquifer properties are in part determined by the complexity of the geohydrologic system, its properties, and the relationship and response of that system to the temporal and spatial variability of recharge and discharge boundaries. Some testing methods may, in fact, adversely affect a contaminant plume that is to be defined. (Lantz-PTT)
W90-08563

MAP3S CHEMISTRY AND DATA ANALYSIS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 7A.
W90-08564

WATER RESOURCES OF THE DANUBE RIVER BASIN; SOURCES OF POLLUTION AND CONTROL AND PROTECTION MEASURES.
Novi Sad Univ. (Yugoslavia). Faculty of Technical Sciences.

For primary bibliographic entry see Field 5B.
W90-08605

STUDIES ON THE CONTAMINATION STATUS OF THE DANUBE RIVER BASIN WATERS, MEASURES OF PROTECTION, AND RATIONAL EXPLOITATION OF THE WATER RESOURCES.
Institute for Biological Research, Belgrade (Yugoslavia). Dept. of Ichthyology.
For primary bibliographic entry see Field 5B.
W90-08610

MEASURES TO BE UNDERTAKEN TO PRESERVE THE TROPHIC STATE OF THE 'NEW DANUBE' AT VIENNA IN THE CASE OF THE CONSTRUCTION OF THE VIENNA-FREUDENAU HYDROPOWER PLANT.
Technische Univ., Vienna (Austria). Inst. fuer Wasserguete und Landschaftswasserbau.
H. Fleckseder.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 145-154, 1990. 7 fig, 1 tab, 14 ref.

Descriptors: *Danube River, *Environmental effects, *Water quality control, *Water quality management, *Water resources development, Austria, Eutrophication, Phosphorus, Self-purification, Trophic level, Vienna, Wastewater treatment.

The 'Neue Donau' (='New Danube') system at Vienna has been erected primarily as a flood protection scheme. It is separated from the main river by a long 200 meter wide island ('Donauinsel'), and has turned out to be a water resort area close to the Vienna City Center with bathing, swimming and surfing along 40 km of beaches. In Vienna, a hydropower plant on the Danube River (Vienna-Freudenau) is under discussion. This paper discusses various alternatives in order to keep the trophic state of the New Danube as it is at present, but also takes into account the left bank water resources questions and the hygienic situation (bathing, swimming, surfing). Under these prerequisites, the following alternatives were compared: (a) complete cutoff plus technical phosphorus (P) removal for the dotation water from the Danube River; (b) complete cutoff plus P-removal in wetlands for the dotation water from the Danube River; (c) partial cutoff plus self-purification as occurrs at the present; (d) complete cutoff, dotation via controlled inlets, and continued self-purification; (e) cutoffs as in the original design, but waiting on the time-scale until P-removal takes place basinwide in wastewater treatment; (f) cutoffs as in the original design, plus a high flow through Danube Island. A comparison of all alternatives indicates that, since eutrophication of the New Danube is phosphorus driven, precipitation of phosphorus in wastewater treatment in the upstream drainage area is the most logical solution. (Agostine-PTT)
W90-08624

MODELING CHANGES IN THE WATER QUALITY OF THE SAVA RIVER CAUSED BY IMPOUNDING WATER AT THE VRHOVO HYDROELECTRIC POWER PLANT.
Ljubljana Univ. (Yugoslavia). Inst. za Zdravstveno Hidrotehniko.
For primary bibliographic entry see Field 6G.
W90-08626

IMPACTS OF RIVER TRAINING ON THE QUALITY OF BANK-FILTERED WATERS.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 6G.
W90-08627

CHANGES IN THE QUALITY OF THE DANUBE RIVER WATER IN THE SECTION SMEDEREVO-KLADOVO IN THE CONDITIONS OF BACKWATER EFFECTS.
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 6G.
W90-08629

DEVELOPMENT OF WATER POLLUTION CONTROL IN AUSTRIA: AN EXAMPLE OF A RIPARIAN STATE IN THE DRAINAGE AREA OF THE RIVER DANUBE.
Technische Univ., Vienna (Austria). Inst. fuer Wasserguete und Landschaftswasserbau.
H. Fleckseder.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 219-226, 1990. 2 tab.

Descriptors: *Austria, *Danube River, *Regulations, *Wastewater treatment, *Water pollution control, Biological wastewater treatment, Industrial wastewater, Lakes, Pulp and paper industry, Rivers, Sludge disposal, Wastewater facilities.

Developments in water pollution control in Austria over a period of 20 years are reviewed. Water pollution control in Austria started in the mid-1960s when eutrophication of lakes came to public awareness and tourism in these resort areas became troubled. The route taken at these lakes was the collection of sewage in the drainage area of the lakes and biological treatment (carbon removal only) before discharging into the outlet river. In 1968, a survey showed that some 40% of the population in Austria had sewerage and 3% biological wastewater treatment, in comparison to some 70% and 40% for West Germany, respectively. In 1988, some 70% of the Austrian population had sewerage and some percentage-points less had biological wastewater treatment. In 1988, industry (except pulp and paper) had biological treatment for 80% of its load, and pulp and paper for 20% of its load. The newest development in water pollution control is a change in the Austrian Criminal Code that was enacted at the end of 1987, and became effective January 1st, 1989, in which 'it is a criminal act to heavily pollute waters even if humans, animals or plants are not endangered'. This new code will curb negligence, both on the side of the polluter as well as on that of the authorities. Foreseeable problem areas in water pollution control for the coming years in Austria can be divided into the following topics: (1) Sewerage and wastewater treatment in less densely populated areas; (2) Improvements in wastewater treatment (nitrification, removal of nitrogen and phosphorus, in certain areas also filtration); (3) Assuring reliable ways of sludge disposal; (4) Bioresistant and ecotoxic compounds; (5) Review of concepts of sewerage and their transfer into practice. Data relating to the main riparian states in the Danube River Basin is tabulated. It is concluded that the actual application of activities in water pollution control seems to be determined primarily by public or political awareness of this specific task and not so much by resources available. (Agostine-PTT)
W90-08634

VIENNA SEWERAGE SYSTEM.
Vienna Municipal Dept., Austria.
For primary bibliographic entry see Field 5D.
W90-08636

RISK MANAGEMENT OF ACCIDENTAL WATER POLLUTION: AN ILLUSTRATIVE APPLICATION.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 7C.
W90-08641

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

ENGINEERING HYDROLOGY TECHNIQUES IN PRACTICE.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
E. M. Shaw.
John Wiley and Sons, New York, New York. 1989. 349p.

Descriptors: *Hydraulic engineering, *Hydraulic structures, *Hydrology, *Water resources manage-

ment, Case studies, Civil engineering, Developing countries, Water deficit, Water resources development, Water supply.

This book is a compendium of schemes and projects which show how the techniques of hydrology are used in the planning, design or operating stages of a scheme. It has been collated from sources which include technical reports from research institutes working directly in the field, water authority reports and consulting engineers reports to clients. There are two broad sub-divisions, the first concerning problems of surplus and excess water, the second with water deficiencies and resources. Investigations are presented in the form of case studies and results from a many countries. Each chapter has an introductory explanation, both of the problems and methods used in their solution: a common format to each case study is the prominent statement of the engineering problem, concentrating on the contribution of the hydrologist and avoiding controversial issues facing design engineers. Each case study also includes a locational map and further technical information in graphs or diagrams where pertinent. Topics covered include hydrometric schemes, agricultural drainage, urban drainage, transport drainage, flood control, reservoir spillways, reservoir yield, irrigation, water resources in several developing countries, river basin development, and water resource-river management. Most of the case studies report experiences in developing countries. A comprehensive index of authors and geographical names, and of hydrological subjects and techniques, assists rapid reference. (Lantz-PTT)
W90-07548

HYDROLOGY AND WATER QUANTITY CONTROL.
University of Central Florida, Orlando. Dept. of Civil Engineering and Environmental Sciences.
For primary bibliographic entry see Field 2A.
W90-07554

LONG-TERM MONITORING OF ELEVEN CORPS OF ENGINEERS HABITAT DEVELOPMENT FIELD SITES BUILT OF DREDGED MATERIAL, 1974-1987.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5E.
W90-07566

MONTE CARLO ANALYSIS AND BAYESIAN DECISION THEORY FOR ASSESSING THE EFFECTS OF WASTE SITES ON GROUND-WATER, II: APPLICATIONS.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 2F.
W90-07615

POST-COMPLETION APPRAISAL: A TOOL FOR WATER INDUSTRY MANAGEMENT.
For primary bibliographic entry see Field 6B.
W90-07899

RIVER BASIN MANAGEMENT: DEVELOPING THE TOOLS.
Water Research Centre, Swindon (England). Swindon Engineering Centre.
For primary bibliographic entry see Field 5G.
W90-07937

CATCHMENT MANAGEMENT DECISION ENVIRONMENT: SOUTH AUSTRALIAN ENGINEERING AND WATER SUPPLY DEPARTMENT AND THE MOUNT LOFTY RANGES.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
P. T. Compagnoni.
Divisional Report 89/5, October 1989. 42p, 2 fig, 22 ref.

Group 6A—Techniques Of Planning

Descriptors: *Australia, *Decision making, *Regulations, *Water resources management, Legislation, Planning Act, Wasteworks Act, Water Resources Act.

The CSIRO Division of Water Resources and the South Australian Engineering and Water Supply Department are producing together a computerized decision support system for planning catchment management. Good system design can follow only from a good understanding of the catchment management decision situation or decision environment which the system is to serve. This report is concerned with the Engineering and Water Supply Department/Mount Lofty Ranges decision environment. It looks back on three pieces of South Australian legislation; the Waterworks Act, 1932-1975; the Water Resources Act, 1976; and the Planning Act, 1982; and regulations under those Acts. It draws from the legislation sections of acts and regulations which enable public control of water catchments and water pollution in the Mount Lofty Ranges. These reflections are accompanied by overviews of the South Australian Engineering and Water Supply Department's 1988 'Review of the Water Resources Act' and its 1988 draft policies for the protection of water resources in the Mount Lofty Ranges prepared the State Government's Mount Lofty Ranges Review. All this provides grounds for an analysis of the Engineering and Water Supply Department's Mount Lofty Ranges catchment management 'decision situation'. The analysis isolates the purpose of legislation, the objects of the Acts, the legal instruments available to the Department and other agencies to act on catchment management, decision procedures useful in developing policies, programs of works (management practices) and land use zoning plans, and the role of consequence analysis in discriminating amongst them. (Author's abstract)
W90-08162

STANDARD HANDBOOK OF ENVIRONMENTAL ENGINEERING.
For primary bibliographic entry see Field 5G.
W90-08177

ENVIRONMENTAL ENGINEERING.
Engineering-Science, Inc., Atlanta, GA.
D. Burstein.
IN: Standard Handbook of Environmental Engineering. McGraw-Hill Publishing Co., New York, New York. 1990. p 1-94, 18 fig, 39 tab, 13 ref.

Descriptors: *Environmental engineering, *Environmental management, *Management planning, Automation, Computers, Construction, Contractors, Economic aspects, Project planning, Training.

The environmental engineering profession has become increasingly diverse as awareness of how the environment affects our lives has increased. Although the major environmental engineering disciplines are reasonably well established, i.e., air, water supply, wastewater, stormwater, solid waste, and hazardous waste, a number of other specialty disciplines also exist. These include noise, radiology, industrial hygiene, oceanography, and the like. This chapter addresses subjects common to all environmental disciplines, such as: contracting for consultant services; project management; project economics; studies and designs; construction; startup and training; and computer utilization. These subjects are discussed primarily from two viewpoints, those of someone in need of environmental services and those of someone providing such services. (See also W90-08177) (Lantz-PTT)
W90-08178

ENVIRONMENTAL LEGISLATION AND REGULATIONS.
Construction Engineering Research Lab. (Army), Champaign, IL.
For primary bibliographic entry see Field 6E.
W90-08179

MONITORING AND EVALUATION OF IRRIGATION PROJECTS.

International Water Resources Association, Oxford (England).
For primary bibliographic entry see Field 3F.
W90-08360

SIMULATED EFFECTS OF FUTURE PUMPAGE ON THE HIGH PLAINS AQUIFER, WEST-CENTRAL UNITED STATES.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2F.
W90-08413

RESOURCE POTENTIALS OF THE RUFIJI RIVER BASIN, TANZANIA.
Dar es Salaam Univ. (Tanzania). Inst. of Resource Assessment.
For primary bibliographic entry see Field 6B.
W90-08445

CONFERENCE ON CLIMATE AND WATER. VOLUME I.
For primary bibliographic entry see Field 2A.
W90-08565

6B. Evaluation Process

TEXAS RAILROAD COMMISSION OIL AND GAS DIVISION UNDERGROUND INJECTION CONTROL PROGRAM: A PEER REVIEW.
For primary bibliographic entry see Field 5G.
W90-07507

MICROCOMPUTER-AIDED PLANNING AT A HYDRO CONTROL CENTRE.
Tennessee Valley Authority, Norris. Engineering Lab.
J. E. Giles, R. K. Jones, P. A. March, H. Armour, and J. M. Epps.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 1, p 16-20, January 1990. 5 fig, 16 ref.

Descriptors: *Computer programs, *Computers, *Data acquisition, *Evaluation, *Hydroelectric plants, *Network design, *Performance evaluation, *Project planning, Data processing, Data quality control.

The Tennessee Valley Authority operates a system of 30 hydro plants, with an installed capacity of almost 5,000 MW. Most of the plants are at multipurpose projects which also provide flood control, navigation, water supply, and recreation. A pilot project was recently initiated to develop on-line instrumentation and microcomputer-based optimization techniques to aid hydro operators in assessing the quality of their units' operation. A three-plant system (consisting of the Cherokee, Douglas, and Norris plants) serves as the testing platform for the project. The plants are operated remotely from the Volunteer hydro control center. The pilot project involves a multi-tasking microcomputer system with multiple windows for performing three primary functions: data logging, performance monitoring, and efficiency optimization. Data logging is accomplished by a spreadsheet which acquires operating data and generates a variety of analyses, daily log sheets, and periodic reports. On-line performance monitoring allows the operator to evaluate the efficiency and cavitation level of the hydro units. At each plant, a microcomputer monitors operating parameters using data acquisition equipment and transducers installed throughout the plant. The data is collected, stored, and subsequently displayed for the operator's use. Optimization software provides guidance for the most efficient operation of the three plants to meet required load scheduling. (Tappert-PTT)
W90-07610

INCORPORATING DAILY FLOOD CONTROL OBJECTIVES INTO A MONTHLY STOCHASTIC DYNAMIC PROGRAMING MODEL FOR A HYDROELECTRIC COMPLEX.
British Columbia Hydro and Power Authority, Vancouver. System Operations and Maintenance

Div.
For primary bibliographic entry see Field 7C.
W90-07634

SCHEDULING MAINTENANCE DREDGING ON A SINGLE REACH WITH UNCERTAINTY.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-07734

SMALL WASTEWATER TREATMENT PLANTS IN SWITZERLAND.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5D.
W90-07771

TECHNIQUES FOR SIMULATING FLOOD HYDROGRAPHS AND ESTIMATING FLOOD VOLUMES FOR UNGAGED BASINS IN EAST AND WEST TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-07843

POST-COMPLETION APPRAISAL: A TOOL FOR WATER INDUSTRY MANAGEMENT.
J. S. Crowther, and L. G. Stone.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 88, No. 1, p 107-113, February 1990. 9 ref.

Descriptors: *Cost analysis, *Management planning, *Project planning, *Water resources development, Capital costs, Evaluation, Future planning, Water management.

Post-completion appraisals (PCAs), sometimes referred to as post-audits, back-checking or post-project audits, are a review of the factors which have contributed to the success or failure of a completed project involving capital expenditures. Within the North West Water Authority of England and Wales, PCAs have been used in a wide range of functions including evaluations of purpose and objectives of projects, project planning, project design, operations, financial planning, and organizational aspects. Up until the beginning of 1987, there was no formal comprehensive system of post-project appraisal within the North West Water Authority. In the last few years several water undertakings have made progress with PCAs. Wessex Water has produced a comprehensive procedure, which forms part of their capital expenditure manual. A PCA report was made for internal use on the construction of a water tower. There have been reports on PCA work in the area of flood protection and land drainage. In 1982, the North West Water Authority adopted a comprehensive formalized system for PCAs. Interim guidelines were drawn up to help in the approach to PCAs based on evaluations of projects in water supply, sewerage, and sewage treatment. These interim guidelines were revised in mid-1987 and again in February 1988. A Plans and Program Manager was appointed under the present system to handle PCAs. At present, three types of PCAs are utilized: full appraisals to be carried out on all aspects of about ten capital projects each year; partial appraisals on a small number of projects each year; and brief appraisals on all other projects completed. The Plans and Program Manager disseminates the results of the appraisals. Seminars and workshops are held regularly to set up PCA systems and audit the workings of the system. The PCA system can establish an archiving system which will be useful in retrieving information on future similar capital proposals. The PCA system must evolve with its accompanying industry to remain a vital part of management in the future. (Geiger-PTT)
W90-07899

EVALUATION OF SOME METHODS OF DETERMINING STORAGE YIELD RELATIONSHIPS FOR IMPOUNDING RESERVOIRS.
Hanley (Ryan) and Co., Galway (Ireland).
J. G. Carty, and C. Cunnane.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 4, No. 1, p 35-43, February 1990. 2 fig, 3 tab, 15 ref.

Descriptors: *Ireland, *Reservoir capacity, *Reservoir storage, *Water storage, *Water yield, Behavior Analysis Method, Climates, Mathematical models, Modified Gould Analysis, Storage-yield analysis.

Twelve methods of storage yield estimation available in the hydrological literature are identified: ripple mass curve analysis, sequential peak analysis, behavior analysis, Waitt's minimum flow analysis, Thompson's minimum flow analysis, Stall and Neill's minimum flow analysis, Hardison's minimum flow analysis, Gould gamma analysis, Dincer analysis, Alexander's method, Moran's method, and the modified Gould method. A time-series model is used to generate a population of 3000 years of synthetic flow data for one set of Irish conditions. The population storage volume for each level of yield and return period is obtained by counting, and the storage estimates obtained using eight selected methods are compared with the population volume on the basis of bias and standard error. The Modified Gould and Behavior Analysis methods were found to have the least bias and the lowest standard error. These methods are therefore recommended for use, in conjunction with simulation methods of investigating storage requirements, for Irish and similar climatic conditions. (Author's abstract)
W90-07931

IMPACT MANAGEMENT PRIORITIES AT WASTE FACILITIES: DIFFERENCES BETWEEN HOST COMMUNITY RESIDENTS' AND TECHNICAL DECISION MAKERS' VALUES.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W90-08007

DECIDING ON A TREATMENT ALTERNATIVE.
Woodward-Clyde Consultants, San Diego, CA.
S. Pearson.
IN: Biotreatment of Agricultural Wastewater. CRC Press, Inc., Boca Raton, Florida. 1989. p 15-31, 8 fig, 6 tab, 40 ref.

Descriptors: *Alternative planning, *Decision making, *Evaluation, *Wastewater treatment, Biological treatment, Biological wastewater treatment, Chemical treatment, Management planning, Physical treatment.

Today, millions of acres of land are irrigated, a practice which has contributed to the high agricultural productivity of the U.S. Unfortunately, agricultural return flow contaminated with heavy metals, pesticides, herbicides and trace metals tends to pollute lakes, streams, marshes, underground aquifers, and other natural bodies of water. The treatment or prevention of agricultural wastewater has been a focus of attention for the last several decades. Because of the large quantities of water which require treatment and the comparatively low capital and operating costs, biological treatment, in its many forms, has attracted attention as a possible solution to many parts of this important treatment problem. It is not technically feasible for biological treatment to solve all agricultural wastewater problems; economic constraints require that it be applied in those situations where it is the most feasible alternative. The general treatment alternatives available for the treatment of agricultural wastewater can be divided into two major treatment categories: (1) physical/chemical treatment systems; and (2) biological treatment systems. While many groupings are possible, biological treatment systems can be divided into two main categories: (1) microbial systems, and (2) aquaculture systems. Physical/chemical treatment systems

utilize physical or chemical processes to remove contaminants from wastewater, and can be grouped into the following eight categories: coagulation and flocculation; sedimentation; filtration; adsorption; ion exchange; membrane processes; chemical oxidation; and thermal processes. While there are many approaches to the evaluation and selection of a treatment alternative, the following system has been used successfully for this type of decision making. The Treatment Evaluation System (TES) consists of seven basic steps: (1) data collection and analysis; (2) identify treatment alternatives; (3) establish screening criteria; (4) screen treatment alternatives; (5) establish evaluation criteria; (6) evaluate feasible treatment alternatives; and (7) rank feasible treatment alternatives. Each of these steps incorporates a set of tasks which focuses the treatment on the specific agricultural wastewater, condition, and environment. The goal of the TES is to select a treatment alternative based upon a careful evaluation which has utilized a set of criteria specifically developed for the particular wastewater being treated. (See also W90-08141) (Lantz-PTT)
W90-08143

CURRENT OPTIONS IN TREATMENT OF AGRICULTURAL DRAINAGE WASTEWATER.
San Joaquin Valley Drainage Program, Sacramento, CA.
For primary bibliographic entry see Field 5D.
W90-08144

ENGINEERING OF MICROALGAE MASS CULTURE FOR TREATMENT OF AGRICULTURAL WASTEWATER, WITH SPECIAL EMPHASIS ON SELENIUM REMOVAL FROM DRAINAGE WATERS.
Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.
For primary bibliographic entry see Field 5D.
W90-08151

RELIABILITY-CONSTRAINED PIPE NETWORK MODEL.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
I. C. Goulter, and F. Bouchart.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 2, p 211-229, February 1990. 1 fig, 5 tab, 24 ref.

Descriptors: *Conveyance structures, *Cost-benefit analysis, *Design criteria, *Economic evaluation, *Pipes, *Water conveyance, *Water distribution, Design flow, Network design, Optimization, Probabilistic process.

A new methodology was developed for incorporating reliability considerations directly into least-cost optimization design models for looped water distribution networks. The essence of the methodology is the measurement of reliability and making changes to the distribution system if the reliability is found to be unsatisfactory. The optimization model constrains the probability of pipe failure for each link and the probability of demand exceeding design values at each node for a fixed flow pattern in the network. The probabilities of pipe failure and demand exceedance are combined into a single reliability measure, the probability of no node failure. Due to the relationship between changing pipe breakage rates and pipe capacity, changing the demand exceedance probability also tends to reduce the probability of pipe failure. On the basis of earlier work, a simple reduction in the probability of the node demand exceeding the design values, through increasing the severity of the design flow, is used to achieve improvement in the probability of no node failure. Application of the procedure to a sample network demonstrated that the procedure is also capable of handling networks in which only one of the contributors to the value of the probability of no node failure can contribute significantly to that probability. If, however, reduction in the expected number of pipe breaks within a network over a given time period is a critical issue, measures that are specifically designed to address the probability of pipe failure appear to be more appropriate. (Author's abstract)

W90-08210

ECONOMIC ASPECTS OF GROUND-WATER WITHDRAWAL PERMIT TRANSFERS.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-08280

IRRIGATION PLANNING BY MULTILEVEL OPTIMIZATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 3F.
W90-08363

RESOURCE POTENTIALS OF THE RUFIJI RIVER BASIN, TANZANIA.
Dar es Salaam Univ. (Tanzania). Inst. of Resource Assessment.
R. B. B. Mwalyosi.
AMBIO AMBOCX, Vol. 19, No. 1, p 16-20, 1989. 3 fig, 20 ref.

Descriptors: *Resources development, *Rufiji River, *Water resources development, *Water resources management, Agriculture, Competing use, Fisheries, Flood plains, Forest watersheds, Hydroelectric power, Management planning, Tanzania.

Tanzania is one of the least developed countries in the world, but has an abundance of available resources. The Rufiji River basin, the largest in the country, is one major tourist attraction. Other potential resources include: agriculture irrigation, hydropower development, fisheries and forestry. There is more than 622,400 hectares suitable for irrigation farming and the Rufiji Basin contains over 60% of the hydropower potential in Tanzania. According to the Rufiji Basin Development Authority (RUBADA), 22 major hydropower sites have been identified. The total hydropower potential in the basin is approximately 4000 MW. However, the Rufiji River and its major floodplains are important fishing grounds, with one-fourth of all fish species in the Lower Rufiji floodplain of commercial value. Approximately 22,900 sq km of the basin is covered by woodland forests; about 4480 sq km comprise 92 protected forest reserves. These forests are also important as a source of water; 18,000 sq km are production forests providing timber and other building material. Properly planned development of these resources could help to boost the economy of the country. But, sustainable development of these resources requires an integrated approach. Regulation of development activities in the basin necessitates conducting an impact assessment of all development projects to eliminate or minimize environmental hazards as well as conflict between projects competing for similar resources. To accomplish this, RUBADA needs to clearly spell out its short-term, medium-term, and long-term operational goals and strategies. It also needs to build up a strong institutional capacity and develop a much more aggressive attitude toward its management activities. (Agostine-PTT)
W90-08445

ECONOMIC ANALYSIS OF TREATMENT TECHNOLOGIES TO ACHIEVE VOLATILE ORGANIC CHEMICAL REMOVAL TO SAFE LEVELS.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5F.
W90-08526

CLIMATIC CONDITIONS OF THE FUTURE.
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR). Research Dept.
For primary bibliographic entry see Field 2B.
W90-08566

WATER RESOURCES OF THE DANUBE RIVER BASIN; SOURCES OF POLLUTION

Group 6B—Evaluation Process

AND CONTROL AND PROTECTION MEAS-URES.
Novi Sad Univ. (Yugoslavia). Faculty of Technical Sciences.
For primary bibliographic entry see Field 5B.
W90-08605

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

HANDBOOK: ESTIMATING SLUDGE MAN-AGEMENT COSTS.
Environmental Protection Agency, Washington, DC. Office of Research and Development.
For primary bibliographic entry see Field 5D.
W90-08176

6D. Water Demand

WATER DEVELOPMENT FOR PHOSPHATE MINING IN A KARST SETTING IN FLORIDA-- A COMPLEX ENVIRONMENTAL PROBLEM.
La Moreaux (P.E.) and Associates, Inc., Tuscaloosa, AL.
For primary bibliographic entry see Field 6G.
W90-07658

MODELING VILLAGE WATER DEMAND BE-HAVIOR: A DISCRETE CHOICE APPROACH.
Asian Development Bank, Manila (Philippines).
X. Mu, D. Whittington, and J. Briscoe.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 521-529, April 1990. 1 fig, 5 tab, 24 ref.

Descriptors: *Africa, *Developing countries, *Water demand, *Water supply, Kenya, Model studies, Water collection.

This study presents a discrete choice model of households' water source choice decisions in developing countries. This model is estimated with data collected by in-depth personal interviews with 69 households in Ukunda, Kenya, a small town south of Mombasa. The results suggest that households' source choice decisions are influenced by the time it takes to collect water from different sources, the price of water, and the number of women in a household. Household income, however, did not have a statistically significant effect. Essentially the same data were used to estimate a traditional water demand model which attempts to explain the quantity of water demanded by a household as a function of collection time, income, and other socioeconomic variables. The discrete choice model can be used to determine the impact of changes in household and source characteristics on the probability that a household will choose a particular water source. (Author's abstract)
W90-07663

AMERICA'S IRRIGATION: CAN IT LAST.
Agricultural Research Service, Fort Collins, CO.
For primary bibliographic entry see Field 3F.
W90-07711

HYDROELECTRIC POTENTIAL IN SOUTH-ERN AFRICA.
H. Olivier.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 88, No. 1, p 115-132, February 1990. 12 fig, 3 ref.

Descriptors: *Africa, *Energy sources, *Future planning, *Hydroelectric power, *Water resources development, Developing countries, Energy transfer, Hydroelectric plants, International agreements, Nonconsumptive use.

With energy supplies on the continent dwindling, and the possibility of political negotiations for water between African countries narrowing, the development of hydroelectric energy through turbines within the territory of each Southern African country seems a promising solution to form a marketable product for developing countries. Once the capital costs of hydroelectric power generation

have been amortized, the operation and mainte-nance costs are minimal. The vast storages re-quired for energy export are found in the mighty rivers in Southern Africa. The export-import system of energy transfer will help to attenuate the annually recurring floods, and provide water for irrigation and other uses downstream. The firm hydroelectric power potential by harnessing the waters of the White Nile in Uganda, the Zambezi, Zaire, Rufiji, Shire and Cunene rivers of Southern Africa is about 70,000 MW. The Zaire at Inga is capable of yielding 40,000 MW. The Zambezi and tributaries can yield about 11,000 MW. Internation-al co-operation in Southern African is seen in the treaty signed in October 1986 between South Africa and Lesotho for the implementation of the massive Lesotho Highlands water scheme. The scheme allows large quantities of water to be di-verted to South Africa from the upper headwaters of rivers in Lesotho and at the same time generates electricity to make Lesotho less dependent on sup-plies from Eskom. Water supplies of up to 70 cu m/sec will reach the Vaal area of South Africa to meet water needs up to early in the 21st century. Such international projects increase job opportuni-ties, agricultural development, and export opportu-nities for Southern African countries. (Geiger-PTT)
W90-07900

WATER SUPPLY.
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5F.
W90-08181

GROUNDWATER CONTAMINATION AND POLLUTION IN MICRONESIA.
Societe Anonyme Francaise d'Etudes, de Gestion, et d'Enterprise, Nanterre (France).
For primary bibliographic entry see Field 5B.
W90-08223

WATER RESOURCES DEVELOPMENT IN COSTA RICA 1970-2000.
Instituto Tecnologico de Costa Rica, Cartago. Dept. de Ingenieria Forestal.
J. C. Calvo.
Hydrological Sciences Journal HSJODN, Vol. 35, No. 2, p 185-196, April 1990. 2 fig, 1 tab, 19 ref.

Descriptors: *Costa Rica, *Developing countries, *Resources management, *Water use, Administra-tive decisions, Legislation, Planning.

The estimated overall annual runoff in Costa Rica is 2200 mm which corresponds to an outflow of 3357 cu m/s. Gross water utilization by hydroelec-tricity, irrigation, navigation and potable-industrial uses has increased significantly during recent dec-ades. An estimate for the year 2000 indicates that the degree of gross water utilization will increase to about 20%. Water resources availability is not a problem per se. There are, however, water scarcity and allocation conflicts due primarily to water pollution and uneven water distribution in time and area. The lack of institutional coordination, inad-equate water legislation, accelerated environmental degradation and absence of water management programs are among the specific policy issues in-volved. Changes in the national policy toward natural resource management within the last two years provide an opening for a new water re-sources management response. These involve the creation of the new Ministry of Natural Resources and the development of the National Strategy for Sustainable development. Multilateral and bilateral development agencies, as well as international pri-vate and voluntary organizations, must support the implementation of this national strategy for the desired objectives to be accomplished. (Author's abstract)
W90-08269

STRIKING A BALANCE IN THE PACIFIC NORTHWEST.
Oregon State Univ., Corvallis. Dept. of Geosci-ences.
For primary bibliographic entry see Field 8I.

W90-08290

WATER SUPPLY AND USE, DALTON LAKE, GEORGIA.
Hydrologic Engineering Center, Davis, CA.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A204-005. Price codes: A10 in paper copy, A01 in microfiche. Special Projects Report No. 86-3, May 1986. 201p, 22 tab, 8 append.

Descriptors: *Dalton Lake, *Georgia, *Water demand, *Water supply, Alternative planning, Coosa River, Coosawatee River, Flow discharge, Seasonal variation, Selective withdrawal, Stream-flow, Water use.

Water supply and use in the Coosa River Basin, Georgia are examined to assess the availability of alternative supplies to the proposed Dalton Lake reservoir project. Streamflow records at 21 gage locations are analyzed to assess the availability of surface water. Withdrawal and discharge records at 364 locations throughout the basin are analyzed to determine water use. It was found that the Coosa Basin stream are both a plentiful supply of water and susceptible to drought. Wet seasons and years provide a good supply source, however, storage is not available to store this supply so the region is also vulnerable to dry periods. An analy-sis of the principal droughts of record shows mean annual flows below the period of record mean annual flow for up to nine consecutive years at some stations. The low flow period in the Coosa Basin are the months of June through November. The June through November flow at several repre-sentative stations have below annual mean stream-flow for the period of record, as expected. With-drawal and discharge data shows that > 90% of the withdrawals in the basin area by six users. Similarly, 80% of the discharge in the basin is by ten users. Consumptive use varies from zero to 86% depending upon the user. A comparison, by hydrologic sub-unit, of 1984 consumptive use shows that it is < 6% of the minimum mean annual streamflow and < 25% of the minimum mean September flow. An alternative supply to Dalton Lake is withdrawal of surface water at Carters downstream from Carters Reservoir. An analysis of the 36-yr historical record shows that there have been approximately 723 days when the streamflow in the Coosawatee River near Carters has fallen below 319 cu ft/sec. The probability of a low flow of 319 cu ft/sec or less lasting for a 7-day duration is approximately 0.38 when the water available in the stream is less than that needed for withdrawal. (Lantz-PTT)
W90-08561

6E. Water Law and Institutions

TEXAS RAILROAD COMMISSION OIL AND GAS DIVISION UNDERGROUND INJECTION CONTROL PROGRAM: A PEER REVIEW.
For primary bibliographic entry see Field 5G.
W90-07507

AGRICULTURAL CHEMICALS AND GROUND WATER QUALITY--ISSUES AND CHAL-LENGES.
Arizona State Univ., Tempe. Dept. of Geology.
For primary bibliographic entry see Field 5B.
W90-07598

EPA REGULATIONS FOR SURFACE WATER TREATMENT AND TOTAL COLIFORMS.
Dallas City Water Utilities Dept., TX. Wastewater Operation.
D. T. Cave.
Southwest and Texas Water Works Journal STWJDV, Vol. 71, No. 10, p 4-7, January 1990. 1 tab.

Descriptors: *Coliforms, *Regulations, *Water treatment, Disinfection, Giardia, Legal aspects, Standards, Surface water, Water law.

The final U.S. EPA regulations for surface water treatment and total coliforms were published in the June 29, 1989, Federal Register. The surface water treatment regulations address the requirements for filtration and disinfection as protection against organisms such as Giardia lamblia and viruses. The regulations provide the basis for determination of which public water systems will be required to filter their water. The disinfection requirements established residual limits in the distribution system along with minimum monitoring requirements, and will be required for all water systems. The residual at the entry to the distribution system cannot be less than 0.2 mg/L for more than four hours in any single instance. Systems serving more than 3300 people will be required to continuously monitor the residual. The total coliform regulations establish minimum sampling requirements to monitor for potential coliform contamination. Systems analyzing at least 40 samples per month must have no more than 5% that are total coliform positive. For systems analyzing fewer than 40 samples per month no more than one sample per month may be total coliform positive. Both regulations provide for consequences resulting from violations, including public notification. (Mertz-PTT)
W90-07660

PRICING OF WATER RESOURCES WITH DEPLETABLE EXTERNALITY: THE EFFECTS OF POLLUTION CHARGES.
Institute of Socio-Economic Planning, University of Tsukuba, Tsukuba, Ibaraki, Japan.
Y. Kitabatake.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 531-537, April 1990. 1 fig, 1 tab, 18 ref.

Descriptors: *Model studies, *Water depletion, *Water pollution control, *Water resources management, Capital assets, Economic aspects, Water resource depletion function.

With an abstraction of a real-world situation, water resources are viewed as a depletable capital asset which yields a stream of services such as water supply and the assimilation of pollution discharge. The concept of the concave or convex water resource depletion function is then introduced and applied to a general two-sector, three-factor model. The main theoretical contribution is to prove that when the water resource depletion function is a concave rather than a convex function of pollution, it is more likely that gross regional income will increase with a higher pollution charge policy. The concavity of the function is meant to imply that with an increase in pollution released, the ability of supplying water at a certain minimum quality level diminishes faster and faster. A numerical example is also provided. (Author's abstract)
W90-07664

TUALATIN RIVER: A COMMITMENT TO WATER QUALITY.
HDR Engineering, Inc., Lake Oswego, OR.
For primary bibliographic entry see Field 5G.
W90-07951

CATCHMENT MANAGEMENT DECISION ENVIRONMENT: SOUTH AUSTRALIAN ENGINEERING AND WATER SUPPLY DEPARTMENT AND THE MOUNT LOFTY RANGES.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 6A.
W90-08162

PROGRAMME AL GHAIT--MOROCCO WINTER SNOWPACK AUGMENTATION PROJECT: A COOPERATIVE PROJECT BETWEEN THE KINGDOM OF MOROCCO AND THE UNITED STATES.
Bureau of Reclamation, Denver, CO. Div. of Research and Lab. Services.
For primary bibliographic entry see Field 3B.
W90-08165

ENSURING THE VIABILITY OF NEW, SMALL DRINKING WATER SYSTEMS: A STUDY OF STATE PROGRAMS.
For primary bibliographic entry see Field 5F.
W90-08168

ENVIRONMENTAL LEGISLATION AND REGULATIONS.
Construction Engineering Research Lab. (Army), Champaign, IL.
R. K. Jain.
IN: Standard Handbook of Environmental Engineering. McGraw-Hill Publishing Co., New York, New York. 1990. p 95-126, 28 ref.

Descriptors: *Environmental management, *Legislation, *Regulations, Federal jurisdiction, Public policy, State jurisdiction.

Environmental legislation, and resulting regulations, are continually evolving. Clearly, environmental regulations can have a profound effect on the economic activity of the country. To provide an understanding of the purpose and function of these requirements, topics covered in this chapter are: rationale for environmental legislation and regulations; concerns regarding environmental legislation and regulations; legislative data systems; an overview of federal environmental legislation (such as Safe Drinking Water Act; Clean Water Act; Resource Conservation and Recovery Act; Comprehensive Environmental Response, Compensation and Liability Act; Toxic and Substances Control Act; and Coastal Zone Management Act); and trends in environmental legislation and regulations. These trends include: (1) adjustments in the federal and nonfederal roles are likely to increase state participation in the enforcement and administration of environmental regulations; (2) balancing of economic and environmental goals is likely to take the form of moderation in achieving some environmental goals which adversely affect economic activities; (3) public support for environmental protection and related life-support systems is expected to continue, especially in the industrialized countries; (4) in the U.S., midcourse correction to major environmental legislation is expected to be made by the legislative bodies. This midcourse correction will be based upon benefits and costs associated with environmental requirements; (5) to the extent possible, regulations will move away from the command-and-control type approach presently used in most cases; (6) with increasing experience in the pollution control technology areas, regulatory controls will move away from the 'hothouse' types of control technologies that deteriorate rather quickly and end up contributing large amounts of pollutants and incurring high operation and maintenance costs during the life cycle of the control devices. Instead, more practical emission standards, with built-in economic incentives, will be established so that cost-effective pollution control technology which provides overall lower pollutants during the life cycle of the equipment could be used; and (7) vigorous public support for incorporating environmental concerns into the decision-making process as embodied in the provisions of legislation, such as the National Environmental Policy Act (NEPA) is expected to continue. (See also W90-08177) (Lantz-PTT)
W90-08179

AIR AND WATER QUALITY STANDARDS.
PEER Consultants, Inc., Washington, DC.
For primary bibliographic entry see Field 5G.
W90-08180

ENVIRONMENTAL ASSESSMENT.
Construction Engineering Research Lab. (Army), Champaign, IL.
R. K. Jain.
IN: Standard Handbook of Environmental Engineering. McGraw-Hill Publishing Co., New York, New York. 1990. p 1215-1251, 7 fig, 7 ref.

Descriptors: *Environmental management, *Legislation, Environmental impact statement, Institutional constraints, Public policy, Regulations.

This chapter includes information necessary in responding to legislation and subsequent regulations

that form the basis for environmental assessments and impact statements. The content and processing of various environmental documents are discussed. To provide an understanding of the impact analysis process, elements related to environmental impact analysis, environmental document review, and public participation are also presented. (See also W90-08177) (Lantz-PTT)
W90-08185

WATER RESOURCES DEVELOPMENT IN COSTA RICA 1970-2000.
Instituto Tecnologico de Costa Rica, Cartago. Dept. de Ingenieria Forestal.
For primary bibliographic entry see Field 6D.
W90-08269

WATER MANAGEMENT: CHALLENGE AND OPPORTUNITY.
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
W. Viessman.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 155-169, March/April 1990. 8 ref.

Descriptors: *Institutional constraints, *Water management, Attitudes, Technology.

Water management is multidimensional. It embraces planning, design, construction, operation and maintenance. Its ingredients include technological capability, social attitudes, economic realities, political viewpoints and environmental goals. Being able to effectively manage water resources often depends more on the ability to maneuver within institutional constraints than to design technological fixes. Our engineering capability is more advanced than its application, yesterday's methods are being applied to tomorrow's problems, and regional problems are begging for solutions because we try to solve them on a local scale. The need for institutional reform is clear, but the key to accomplishing it is elusive. Both resource-related and institutional factors must be considered. Accordingly, potential avenues for reform are presented in that context. The challenge is to face today's and tomorrow's problems with tools appropriate to the times and to the special features of the locality being served. (Author's abstract)
W90-08272

ECONOMIC ASPECTS OF GROUND-WATER WITHDRAWAL PERMIT TRANSFERS.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-08280

OVERCOMING FEDERAL WATER POLICIES.
California State Dept. of Water Resources, Sacramento. Financial Assistance and Environmental Review Branch.
A. L. Riley.
Environment ENVTAR, Vol. 31, No. 10, p 12-20/ 29-31, December, 1989. 7 fig, 17 ref.

Descriptors: *Environmental effects, *Federal jurisdiction, *Flood control, *Flood plains, *Sediments, *Streams, *Water management, *Water policy, California, Cost-benefit analysis, Marsh management, Multiobjective planning, North Richmond, San Pablo Creek, Wildcat Creek.

The flooding of the Wildcat and San Pablo Creeks in Contra Costa County, California, puts the impoverished community of North Richmond under about a foot of water once every three years. In 1968, the Army Corp of Engineers issued a report that presented several different flood control plans, but no one plan was recommended because the projects did not pass the cost-benefit test. In the 1970s, the corps based its planning on the multiple objectives of the Richmond Model Cities Plan, which focused on social well-being, environmental quality, and economic redevelopment. In the 1980s, federal policies reverted to favoring the construction of projects based on a single objective

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of economic efficiency. A coalition of North Richmond community groups developed a 'Modified Plan' which proposed changing existing creek channels to simulate the natural hydraulic shape and processes of undisturbed streams, deposit the sediment in the upstream floodplain, and restore valuable riparian vegetation. A design team chose features from the Selected plan of the county and Army Corps of Engineers and from the Modified Plan and designed a Consensus Plan in which sediment deposition will occur on the floodplain and in the bay and not in the marsh. Technical issues faced included estimating the sediment loads carried by the creeks, assessing the capacity of the corp's proposed sediment basin, judging the safety of concrete box culverts, and assigning roughness values to proposed revegetation areas. The multiobjective project to restore marshes, provide recreational and educational opportunities, enhance the environment, and control flood damages attracted funding from a variety of state agencies. (MacKeen-PTT)
W90-08289

CLEANING THE RIVER GANGA: RHETORIC AND REALITY.
Cambridge Univ. (England). Faculty of Social and Political Science.
For primary bibliographic entry see Field 5G.
W90-08449

RISK MANAGEMENT FOR REGULATORY PURPOSES.
Environmental Protection Agency, Washington, DC. Div. of Water Supply.
S. W. Clark.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 525-542, 1 tab, 20 ref.

Descriptors: *Drinking water, *Regulations, *Standards, *Volatile organic compounds, *Water quality control, Aeration, Benzenes, Carbon tetrachloride, Costs, Dichlorobenzene, Dichloroethane, Dichloroethylene, Granular activated carbon, Maximum contaminant level, Public health, Safe Drinking Water Act, Trichloroethane, Trichloroethylene, Vinyl chloride, Water treatment.

The maximum contaminant levels (MCLs) for eight volatile organic compounds (VOCs) were among the first revised drinking water standards promulgated as a result of the Safe Drinking Water Act (SDWA) Amendments of 1986. This rule has significance beyond these eight compounds in that it has stimulated development of a process that EPA can follow for future regulations. For VOCs, one of the first decision points was whether to have an MCL or a treatment technique rule. An MCL rule was selected since these contaminants can be measured in drinking water. Since some of the maximum contaminant level goals (MCLGs) were set at zero, the MCLs were strongly influenced by treatment performance and measurement capabilities. Development of best available technology criteria led to the selection of GA adsorption and packed tower aeration technologies which are capable of cost-effective treatment to levels below analytical detection limits. The need for a reliable measurement technique led to the development of the practical quantification level concept, which was an important component in setting the MCL. At the same time, an acceptable risk range of 0.0001 to 0.000001 individual lifetime risk of cancer was set which, along with treatment, cost, and analytical measurement considerations, yielded the final MCLs. Finally, system-level costs and total national costs and benefits were evaluated for various MCL levels. When all of this information was evaluated and integrated, the eight MCLs were promulgated: benzene, 0.005 mg/L; vinyl chloride, 0.002 mg/L; carbon tetrachloride, 0.005 mg/L; 1,2-dichloroethane, 0.005 mg/L; trichloroethylene, 0.005 mg/L; p-dichlorobenzene, 0.075 mg/L; 1,1-dichloroethylene, 0.007 mg/L; and 1,1,1-trichloroethane, 0.20 mg/L. (See also W90-08509) (Lantz-PTT)
W90-08531

HYDROCHEMICAL MONITORING AND HYDROGEOLOGIC CHARACTERIZATION: CONFLICT AND RESOLUTION.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5G.
W90-08563

WATER BIOLOGICAL SUFFICIENCY AND QUALITY OF THE BULGARIAN DANUBE STRETCH (845-375 RIVER KM).
Bulgarian Academy of Sciences, Sofia. Inst. of Zoology.
For primary bibliographic entry see Field 5A.
W90-08618

DEVELOPMENT OF WATER POLLUTION CONTROL IN AUSTRIA: AN EXAMPLE OF A RIPARIAN STATE IN THE DRAINAGE AREA OF THE RIVER DANUBE.
Technische Univ., Vienna (Austria). Inst. fuer Wasserguete und Landschaftswasserbau.
For primary bibliographic entry see Field 5G.
W90-08634

6F. Nonstructural Alternatives

SPECIAL FLOOD HAZARD EVALUATION REPORT: DONNER CREEK, CITY OF NORTH TONAWANDA, NIAGARA COUNTY, NEW YORK.
Army Engineer District, Buffalo, NY.
For primary bibliographic entry see Field 2E.
W90-08559

6G. Ecologic Impact Of Water Development

SIMULATING THE INDIRECT EFFECTS OF POWER PLANT ENTRAINMENT LOSSES ON AN ESTUARINE ECOSYSTEM.
Versar, Inc., Columbia, MD. Ecological Sciences and Analysis Div.
J. K. Summers.
Ecological Modelling ECMODT, Vol. 49, No. 1/2, p 31-47, December 1989. 2 fig, 4 tab, 31 ref.

Descriptors: *Ecological effects, *Electric powerplants, *Entrainment, *Estuaries, *Fish entrainment, *Fish mortality, *Model studies, Bass, Bluefish, Data interpretation, Ecosystems, Fish food, Fish populations, Maryland, Patuxent River, Population dynamics, Weakfish.

Entrainment caused by the operation of the Chalk Point Steam Electric Station has been shown to be a major source of mortality to the early life stages of forage fish populations in the Patuxent River, Maryland. While direct losses to these populations are important as a source of reduction for population abundance, these losses also represent decreases in estuarine forage supplies and potential reductions in the abundance of estuarine predators. A simple estuarine trophic dynamics model was constructed to determine the magnitude of the potential losses to major estuarine consumers in the Patuxent River ecosystem due to the power plant-related losses of forage fish. Simulations were completed using two sets of feeding assumptions: feeding proportional to forage abundance, and feeding based on dietary preferences. The model demonstrates that striped bass, bluefish, and weakfish could experience significant losses (>25%) to overall population production levels if they prefer to prey upon bay anchovy and silversides with entrainment losses to these forage populations > or = 70% of juvenile recruitment. The model also shows that indirect predator losses would be expected to be low (<5%) if the majority of their diets consisted of forage other than bay anchovy and silversides. (Author's abstract)
W90-07653

WATER DEVELOPMENT FOR PHOSPHATE MINING IN A KARST SETTING IN FLORIDA--A COMPLEX ENVIRONMENTAL PROBLEM.
La Moreaux (P.E.) and Associates, Inc., Tuscaloosa, AL.
P. E. Lamoreaux.
Environmental Geology and Water Sciences EGWSEI, Vol. 14, No. 2, p 117-153, September/October 1989. 28 fig, 5 tab, 172 ref.

Descriptors: *Florida, *Groundwater management, *Regulations, *Water law, *Water supply, Aquifer management, Groundwater availability, Legal aspects, Permits, State jurisdiction, Water management, Water use.

The state of Florida passed legislation in the early 1970s and developed regulations applied to large withdrawals of groundwater. These regulations require strict adherence to defining the impact on surface water, shallow surficial aquifers, and the deeper aquifers within the Floridan Aquifer System. These regulations require the development of a Regional Impact Statement and a Consumptive Use Permit. To meet these requirements it is necessary to perform surface and groundwater studies, extensive pumping tests, and collect detailed monitoring and water quality data. These permits fall under the jurisdiction of the Florida Department of Environmental Regulators and are administrated under the Regional Water Management District (such as the Southwest Florida Management District). These regional district offices have a regulatory hearing board, hold public hearings that are properly advertized, and have support staffs of geologists, chemists, and biologists. The Florida Code involved requires that, 'The water crop, in the absence of data to the contrary, is 1000 gallons/day/acre.' A 5-3-1 Criteria also applies that requires that a determination be made to show that there will not be more than a 5-foot average decline in water level in the Floridan Aquifer at the boundary of a property to be developed; not more than a 3-foot decline in the Surficial Aquifer at the boundary; and no more than a 1-foot decline in the nearest water body (pond, lake, etc.). In addition, surface water flow in streams of the area must not be decreased more than 5% unless a variance to the rule is obtained. (Author's abstract)
W90-07658

SALINITY CHANGES IN CHARLESTON HARBOR 1922-1987.
South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.
For primary bibliographic entry see Field 2L.
W90-07733

EFFECTS OF RIVER DISCHARGE AND HIGH-TIDE STAGE ON SALINITY INTRUSION IN THE WEEKI WACHEE, CRYSTAL, AND WITHLACOOCHEE RIVER ESTUARIES, SOUTHWEST FLORIDA.
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 2L.
W90-07842

IN SEARCH OF AN EARTH ETHIC.
A. B. Nichols.
Water Environment & Technology, Vol. 2, No. 3, p 36-41,81, March 1990. 3 fig.

Descriptors: *Environmental policy, *Environmental protection, *Ethics, *Pollution control, *Public opinion, Aesthetics, Climatology, Developing countries, Economic evaluation, Ecosystems, Global warming, Historical perspective, Industrial development, Natural resources, Public health, Regulations, Safety.

Environmental ethics is both an academic discipline and a main thread running thorugh the larger ecological movement. As an academic discipline, it aspires to a legitimacy now enjoyed by other disciplines. The environmental movement is essentially about man's values, duties, and responsibilities towards nature. Historically, the movement has been diverse, encompassing many different perspectives on a wide ideological spectrum. Environmentalists of all persuasions develop their arguments from various ethical systems; some draw on classical ethics to develop an anthropocentric ethic towards

nature; others aim to develop an ecocentric ethical system. In the USA, public values are reflected in pollution control and environmental protection laws. Embedded in these laws is the belief that the integrity of our natural resources, as well as public health and safety, should be maintained. Public values are often predicated on intangibles, such as a sense of aesthetics. The tools of conventional economic analysis may be inadequate to assess intergenerational risk in areas such as global warming. Ethicists need to work with climatologists to develop models which will protect future generations. In less developed countries, industrialization has a much higher priority than pollution reduction. Man must recognize that he is a part of nature on which his existence depends and economic activity must account for the environmental costs of production. (Brunone-PTT)
W90-07950

ZOOPLANKTON COMMUNITY CHANGES IN LAKE KINNERET (ISRAEL) DURING 1969-1985.
Kinneret Limnological Lab., Tiberias (Israel).
For primary bibliographic entry see Field 2H.
W90-08070

EVALUATION OF CLAMSHELL DREDGING AND BARGE OVERFLOW, MILITARY OCEAN TERMINAL, SUNNY POINT, NORTH CAROLINA.
Waterways Experiment Station, Vicksburg, MS.
M. R. Palermo, J. Homziak, and A. M. Teeter.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-90-6, March 1990. Final Report. 70p, 17 fig, 9 tab, 85 ref.

Descriptors: *Dredging, *Environmental effects, *Estuarine sediments, *Suspended solids, *Water pollution sources, *Water resources development, Channel improvement, Clamshell dredge, Water quality.

The 1987 maintenance dredging for the Military Ocean Terminal, Sunny Point (MOTSU), North Carolina, project was performed by mechanical clamshell dredge, with material placed in barges and transported to an open water ocean disposal site. The loading characteristics of the barges for both overflow and non-overflow conditions and potential gain in load due to overflow were determined for three barge loads. The load gained during the period of overflow varied from 1.4 to 3.2%, with corresponding times of overflow from 9 to 28 minutes. The load gained by filling the disposal barge in one test from a level 1 ft below the coaming to the point of overflow was approximately 6.9%. This, added to the load gained during overflow, corresponded to a total increase in load of 10.1% for this test. The suspended solids concentration of the overflow increased with time of overflow. The average concentration at the start of overflow was 88 g/L as compared with 248 g/L at the end of overflow. Plumes from the clamshell bucket spillage were observed to be patchy in nature, were advected downcurrent, and mixed with the ambient water downstream. The average suspended solids concentration of samples in the plumes generated by dredging was 47 mg/L above the background, while that for plumes generated by dredging with overflow was 65 mg/L above background. The suspended solids concentrations in the plumes were reduced to near-background levels at short distances from the dredging activity. An analytical model indicated the material in the plumes settles rapidly without being transported, and only a small fraction of the suspended material would go into far-field suspension. A literature review was conducted to evaluate the potential biological effects of the dredging overflow. Eggs, larvae, juveniles, and adult forms of estuarine-dependent fish and shellfish species appear to be very tolerant to elevated suspended solids concentrations. When viewed against data on naturally occurring minimum, average, and maximum suspended sediment concentrations at this site, the suspended sediment levels observed during dredging and overflow most probably did not produce any significant adverse environmental effect. (Lantz-PTT)

W90-08139

DESIGN FOR SALADO RESEARCH.
Roosevelt Monograph Series 1, Anthropological Field Studies 22, January 1990. 192p, 23 fig, 15 tab. Edited by Glen E. Rice. Bureau of Reclamation Contract 9-CS-32-06230.

Descriptors: *Archaeology, *Arizona, *Roosevelt Lake, *Social aspects, Salado, Sonoran Desert, Tonto Basin, Water resources development.

The Roosevelt Platform Mound Study will examine three classic period communities in the Tonto Basin, Arizona. Seventy-nine sites will be investigated over a 8-year period, 4 of which will be spent in the field. This volume presents the research framework for these investigations, outlines the field approach and the special studies to be conducted. The focus of this research is the study of organizational complexity. The contributing authors argue that the Salado phenomenon can be best understood as the material manifestation of a more complex social organization that developed among the societies of the large river valleys of Arizona's Sonoran Desert around A.D. 1100. Part of the research is oriented toward a more thorough identification of the criteria that would allow for a better characterization of the Tonto Basin in culture history units. Another part of the research will seek to measure the genetic affinity of the people who occupied the Tonto Basin, to determine if they were more closely related to the people of Grasshopper or the lower Salt River valley. The study provides a truly ecological approach to the study of the past. A component of the research is oriented toward reconstructing the prehistoric landscape, both in the distribution of different kinds of microenvironments and in terms of the changes that could have occurred through cyclical patterns of erosion. The Bureau of Reclamation has plans for two other parallel projects that will add further detail on site diversity and function in the Tonto Basin area. One of these will focus on small rural sites associated with agricultural terraces on the slopes above the valley bottom. The second of these projects will focus on a sequence of pre-Classic and Classic sites that can be used to document the development of the platform mound complexes in the Tonto Basin. The results of these two ancillary projects will be used in conjunction with these findings to prepare an overall synthesis of the prehistory of the Tonto Basin. (Lantz-PTT)
W90-08174

ENVIRONMENTAL ASSESSMENT.
Construction Engineering Research Lab. (Army), Champaign, IL.
For primary bibliographic entry see Field 6E.
W90-08185

OVERCOMING FEDERAL WATER POLICIES.
California State Dept. of Water Resources, Sacramento. Financial Assistance and Environmental Review Branch.
For primary bibliographic entry see Field 6E.
W90-08289

LONGITUDINAL STRUCTURE OF AN AGRICULTURAL PRAIRIE RIVER SYSTEM AND ITS RELATIONSHIP TO CURRENT STREAM ECOSYSTEM THEORY.
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 2H.
W90-08437

IMPACT OF FURTHER IMPOUNDMENTS ON THE OXYGEN BALANCE AND WATER QUALITY OF THE DANUBE IN GERMANY.
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
D. Muller, and V. Kirchesch.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 69-78, 1990. 7 fig, 1 tab, 6 ref.

Descriptors: *Dam effects, *Danube River, *Reservoirs, *Water pollution effects, *Water resources development, Ecological effects, Flow velocity, Low flow, Mathematical models, Model studies, River sediments, Streamflow, West Germany.

The construction of two or three impounding dams along the remaining freely flowing reach (73 km) of the Danube, the purpose of which is to guarantee a minimum navigable depth of 3 meters needed for modern cargo ships and to produce electric power, is discussed. The impact of these developments is discussed on the basis of experience with similar impoundments further upstream and results from water quality model calculations. The mathematical model used is of the deterministic type, calculating the growth of slowly growing organisms (nitrifying bacteria, algae and zooplanktons) according to MONOD and MICHAELIS-MENTEN. The impoundment regulation of this reach of the Danube would lead to an increase in flow times of about 1.5 days at mean low flow (MLQ) and 0.4 days at mean flow (MQ). Compared with impoundments on other German rivers or the Iron Gate impoundments on the Danube, the effect of these new impoundments on water quality parameters is likely to be minimal. The most pronounced change would most probably consist of a certain reduction in the diurnal fluctuations of the oxygen content. Considerable changes are expected in flow velocities and, as a result of these changes, in the characteristics and colonization of the stream bed, over a distance of 10 to 15 km. (Agostine-PTT)
W90-08614

DOWNSTREAM EFFECTS OF INTERMITTENT POWER GENERATION.
Biological Station, Lunz am See (Austria).
G. Bretschko, and O. Moog.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 127-135, 1990. 3 fig, 5 tab, 16 ref.

Descriptors: *Dam effects, *Danube River, *Ecological effects, *Electric power production, *Water level fluctuations, *Water resources management, Artificial floods, Austria, Bottom sediments, Bregenzerach River, Ecology, Enns River, Fluctuations, Low flow, Water resources development, Water supply.

For intermittent power generation water is stored in a dammed part of the river channel or in special impoundments. During the relatively short but very frequent times of power generation (about 3X/day) most of the stored water is released through the turbines. Thus, intermittent power generation causes frequent and dramatic discharge peaks combined with intervening extremely low water conditions. This highly artificial discharge regime adversely affects the stream biocenoses, in permanently flooded as well as in periodically flooded channel areas. Unlike artificially induced floods, 'natural' floods do not act as disturbances on the river biocenoses. The data presented in this paper indicate that beside size and frequency of man-induced floods, the unnatural independency of surface and groundwater hydrology might be a reason for the adverse effects of intermittent power generation. Two Austrian rivers were studied, the Bregenzerach, which drains into the Rhine system and flows in the western most part of Austria, and the Enns River, which drains directly into the Danube. Both rivers are highly influenced by intermittent power generation. Sampling was done using the freeze-core method. The method allows the study of the vertical distribution of the fauna in the bed sediments as well as estimations of abundance in channel areas with dry sediment surfaces. Whereas no alterations were found in the qualitative composition of zoobenthos, the decrease in abundance and biomass may amount to up to 95%. The mismatch between the hydrography of surface and groundwater might well be a cause of the detrimental effects of frequent and artificially created spates. The drastic reduction of zoobenthic biomass affects not only fish production, but minimizes self-purification processes as well. Until tributaries diminish the effects of intermittent power generation, the river is reduced to a mere transport vehicle. (Agostine-PTT)
W90-08622

Group 6G—Ecologic Impact Of Water Development

NUTRIENT INPUT AND TROPHIC STATUS OF THE 'NEUE DONAU', A HIGH-WATER CONTROL SYSTEM ALONG THE RIVER DANUBE IN VIENNA, AUSTRIA.
Institut fuer Limnologie, Mondsee (Austria).
M. T. Dokulil, and G. A. Janauer.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 137-144, 1990. 8 fig, 11 ref.

Descriptors: *Danube River, *Environmental effects, *Land use, *Nonpoint pollution sources, *Nutrient concentrations, *Water pollution sources, *Water resources development, Austria, Macrophytes, Nitrogen, Phosphorus, Vienna.

The artificial canal-like system 'Neue Donau' functions as a control for high waters of the Danube River and is an important recreational area for many people. Water quality and trophic status of the water body is therefore of prime importance. The high nutrient concentrations of the Danube River (P-tot 238 +/-41 micrograms/L, N-tot 2.53 +/-0.78 micrograms/L) reach the system via groundwater seepage. Present conditions in the basin of the Neue Donau are, as a result of this nutrient influx, eutrophic to hypertrophic. Average values during the summer period have declined from 366 micrograms/L total phosphorus to 78 micrograms/L, and from 86 micrograms/L chlorophyll-a to 17 micrograms/L between, 1985 and 1988. However, a dam which is planned in the river at Vienna will permanently raise the water level of the river thus increasing the groundwater flow in the direction of the Neue Donau, and it's nutrient input. This will enhance trophic conditions in the impoundment. Since macrophytes play an important role in one part of the system, macrophyte management together with measures along the river are some of the suggested strategies to keep the system Neue Donau at acceptable trophic conditions and good water quality. (Author's abstract)
W90-08623

MEASURES TO BE UNDERTAKEN TO PRE-SERVE THE TROPHIC STATE OF THE 'NEW DANUBE' AT VIENNA IN THE CASE OF THE CONSTRUCTION OF THE VIENNA-FREU-DENAU HYDROPOWER PLANT.
Technische Univ., Vienna (Austria). Inst. fuer Wasserguete und Landschaftswasserbau.
For primary bibliographic entry see Field 5G.
W90-08624

EFFECTS OF WARM WASTEWATERS FROM THERMAL POWER STATIONS ON ECOSYS-TEMS OF THE SAVA AND THE VELIKA MORAVA, TRIBUTARIES OF THE DANUBE.
Institute for Biological Research, Belgrade (Yugoslavia). Dept. of Ichthyology.
D. V. Jankovic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 155-160, 1990. 1 tab, 11 ref.

Descriptors: *Ecological effects, *Electric power-plants, *Thermal pollution, *Water pollution effects, *Water resources development, Dissolved oxygen, Ecosystems, Fish growth, Growth rates, Industrial wastewater, Nitrates, Phosphates, Seasonal variation, Sulfates, Water pollution sources.

Investigations were conducted, from 1977 to 1989, into the effects of warm wastewaters from thermal power stations on ecosystems of the Sava and the Velika Morava, tributaries of the Danube River in Yugoslavia. The thermal power stations (TPSs) were the 'Morava' TPS, situated near Svilajnac on the Morava River, and 'Nicola Tesla A and B' TPSs near Obrenovac an the Sava River. These rivers also receive industrial and urban wastewaters along their entire length. The temperature differences between the river waters abstracted and the wastewaters returned to the rivers were from 8 to 15 C. In the areas influenced by these warm wastewaters, greater heterogeneity of ichthyofauna and faster growth and maturation of fish were observed. These were considered to be positive effects. Due to the periodic washing out of TPS coal ash repositories which are located in the riparian areas, concentrations of sulfates, phosphates, and nitrates have been increasing in the

Morava, which may have negative effects on the aquatic communities. High ambient temperatures in the summer, during periods of low water and reduced oxygen content in the polluted river conditions, also had negative effects on the water ecosystems. The warm wastewaters from the thermal power stations could be used in aquaculture, which would decrease the thermal pollution of the rivers during the summer lower water periods. (Author's abstract)
W90-08625

MODELING CHANGES IN THE WATER QUALITY OF THE SAVA RIVER CAUSED BY IMPOUNDING WATER AT THE VRHOVO HYDROELECTRIC POWER PLANT.
Ljubljana Univ. (Yugoslavia). Inst. za Zdravstveno Hidrotehniko.
U. Krajnc, and M. Rismal.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 161-166, 1990. 2 fig, 4 tab, 9 ref.

Descriptors: *Hydroelectric plants, *Model studies, *Reservoirs, *Sava River, *Water quality control, *Water quality management, *Water resources development, Danube River, Dissolved oxygen, Industrial wastewater, Mathematical models, Wastewater treatment, Water quality, Yugoslavia.

The Sava River, which is the main Yugoslav tributary of the Danube, is of poor quality, and is classified as a third or fourth quality class river. The need for improving the Sava River water quality was anticipated by the planned construction of 7 hydroelectric powerplants on the reach between Zidani and the republic border. In addition, a parallel water quality program was instituted, consisting of the construction of 11 municipal wastewater treatment plants and 9 pretreatment plants for industrial wastewater. In order to formulate objectives and prioritize water quality goals, the mathematical model QUAL II was used, but was restricted by the lack of recorded data. As a result of these simulations, the following conclusions were made: (1) Retention time will significantly increase after completion of the Vrhovo hydroelectric power plant (HEPP). (2) The dissolved oxygen level will decrease, and will be most noticeable during low discharges in the Sava and at high temperatures; (3) Longer retention times in the reservoir will cause a reduction of organic pollution expressed as biochemical oxygen demand for 5 hours; (4) Nitrification will occur; and (5) Larger retention times will cause the reduction of coliform levels. The following priority tasks are proposed for the Sava River sanitation project: (a) Disposable funds should first be directed toward larger sewer systems which conduct municipal and industrial wastewater; and (b) from an ecological and socio-economical standpoint, pretreatment of industrial wastewater should be performed to reduce toxicity and suspended solids. (Agostine-PTT)
W90-08626

IMPACTS OF RIVER TRAINING ON THE QUALITY OF BANK-FILTERED WATERS.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
F. Laszlo, Z. Homonnay, and M. Zimonyi.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 167-172, 1990. 5 fig, 2 ref.

Descriptors: *Environmental effects, *Groundwater management, *Infiltration, *River training, *Stream banks, *Water quality control, *Water resources development, Bank filtered water, Drinking water, Groundwater quality, Groundwater recharge, Hungary, Water quality, Water resources management.

The importance and share of bank filtered waters as a source of municipal water supply in Hungary are unparalleled even on an international scale. Close to 40% of the water delivered by the public water companies originates from bank filtered resources. The physical, chemical and bacterial quality of bank filtered water depends on a number of factors and is controlled by: the quality of water in the stream, the properties of the filter layer, the

velocity of seepage flow, the residence time in the gravel layer, and the quality of water arriving from the background areas. The most important factor is the quality of surface water in the feeding stream. A necessary criterion is that the quality of river water (raw water) should be high enough to permit the production of wholesome drinking water by the natural process of bank filtration followed by disinfection, without any additional treatment operations. The impacts of river training and gravel dredging on the quality of bank filtered waters are considered along the Danube sections upstream and downstream of Budapest, where important sources of drinking water are situated. Case studies are presented to show that training structures and dredging operations affect the hydraulic conditions in the river that are conducive to silting in areas with reduced flow velocities. Adverse hydrochemical changes occur in the silted filter layer, especially the dissolution of iron and manganese, and higher concentrations of ammonia ions are observable. Dredging tends to disrupt the biologically active filter layer, while the ensuing bed degradation causes changes in the inflow ratio, increasing the proportion of polluted groundwater from the background areas in the wells. (Agostine-PTT)
W90-08627

SEDIMENTATION IN THE RESERVOIR OF THE ALTENWOERTH HYDROPOWER PLANT.
Universitaet fuer Bodenkultur, Vienna (Austria). Inst. fuer Wasserwirtschaft.
For primary bibliographic entry see Field 2J.
W90-08628

CHANGES IN THE QUALITY OF THE DANUBE RIVER WATER IN THE SECTION SMEDEREVO-KLADOVO IN THE CONDITIONS OF BACKWATER EFFECTS.
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
M. Perisic, M. Miloradov, V. Tutundzic, and Z. Cukic.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 181-188, 1990. 5 fig, 2 tab, 11 ref.

Descriptors: *Environmental effects, *Water resources development, Bottom sediments, Danube River, Dissolved oxygen, Organic matter, Plankton, Sedimentation, Species diversity, Turbidity, Water pollution effects, Water pollution sources, Water quality.

The paper describes specific changes in the quality of the Danube river water under the conditions of backwater effects from the Hydropower Plant Djerdap I storage, from Smederevo to Kladovo. Changes in the composition of the water in this section were analyzed for five profiles: organic matter, oxygen regime, reduction of turbidity, and changes in the composition and abundance of plankton. Investigations were made at three sampling points (at the left bank, central flow and the right bank) at characteristic discharges (spring high water, summer and autumn low water) using standard analytical methods. Analysis of phytoplankton and zooplankton (qualitative and quantitative composition) was made with regard to species. Changes in the flow conditions (rate and geometrical characteristics) lead to changes in the conditions for: depositing suspended material; reaeration; and plankton development. Sedimentation processes in the backwater result in a high level of reduction of suspended and organic degradable matter. The released organic load is broken down in the reservoir with effects which improve with longer retention times and flow rates. Compensation for the dissolved oxygen consumed in the process of biochemical degradation in the open reservoir, is mostly made through the process of reaeration; the efficiency of this process does not produce a favorable oxygen balance, resulting in an increased deficit throughout the watercourse. The decrease in plankton diversity and abundance along the studied section brings about decreased production in the lower part of the reservoir. The sedimentation processes and, above all, mixing effects with changed geometrical char-

acteristics, are limiting factors for production in the reservoir, requiring clarification through further investigation. (Agostine-PTT)
W90-08629

RADIOACTIVITY OF SEDIMENTS IN DANUBE RESERVOIRS IN AUSTRIA BEFORE AND AFTER THE CHERNOBYL ACCIDENT.
Bundesversuchs- und Forschungsanstalt Arsenal, Vienna (Austria). Geotechnical Inst.
For primary bibliographic entry see Field 5B.
W90-08633

7. RESOURCES DATA

7A. Network Design

WELL INSTALLATION AND GROUND-WATER SAMPLING PLAN FOR 1100 AREA ENVIRONMENTAL MONITORING WELLS.
Battelle Pacific Northwest Labs., Richland, WA.
R. W. Bryce.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-012220. Price codes: A06 in paper copy, A01 in microfiche. Report No. PNL--6815, May 1989. 175p, 4 tab, 26 ref, 6 append. DOE Contract DE-AC06-76RL0-1830.

Descriptors: *Groundwater quality, *Hanford Site, *Monitoring, *Monitoring wells, *Network design, *Washington, Geohydrology, Richland, Water quality, Water supply, Well construction.

The Hanford Site, operated for the U.S. Department of Energy (DOE) by Westinghouse Hanford Company, consists of several functional areas. The 1100 Area, near the city of Richland, has been used for maintenance activities. Waste disposal sites in the 1100 Area received unknown quantities of liquid and solid waste between 1950 and 1985 including spent battery acid, antifreeze, used motor oils, solvents, degreasers, paints, and paint thinner. These disposal sites are close to wells that supply water to Richland, Washington. Although no contaminants have been observed in water samples taken from the water supply wells, five monitoring wells will be installed between the waste disposal sites and the wells supplying water to Richland to detect any possible contaminants in the groundwater before they reach the water supply wells. The groundwater monitoring system in the vicinity of the 1100 Area and the North Richland Well Field will provide groundwater quality and potentiometric data in the vicinity of the 1100 Area waste disposal facilities and the Richland water supply wells. This plan describes the existing waste disposal facilities and water supply wells, geohydrology of the area, well completion specifics, and the data to be gathered from the five new wells. (Author's abstract)
W90-07552

WATER SAMPLING.
For primary bibliographic entry see Field 7B.
W90-07553

ACCOUNTING FOR TEMPORAL VARIATIONS IN LARGE-SCALE RETROSPECTIVE STUDIES OF AGRICULTURAL CHEMICALS IN GROUND WATER.
Research Triangle Inst., Research Triangle Park, NC. Hydrogeology Dept.
S. K. Liddle, R. W. Whitmore, R. E. Mason, W. J. Alexander, and L. R. Holden.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 142-146, Winter 1990. 3 fig, 19 ref.

Descriptors: *Agricultural chemicals, *Fluctuations, *Groundwater chemistry, *Groundwater pollution, *Network design, *Statistical methods, *Water chemistry, Alachlor, Sampling, Surveys.

Groundwater studies that require long data collection periods may be affected by temporal changes in groundwater chemistry. Seasonal fluctuations in groundwater chemistry are particularly apparent

in shallow aquifers. Of specific interest is the inclusion of temporal variability in the design of statistical surveys of agricultural chemicals in well water. Statistical treatment of temporal variability involves selecting a probability sample from temporal units. The selection strategy may include repeating the same spatial units in each temporal stratum or choosing an independent sample of spatial units for each temporal stratum. The appropriate strategy depends on the specific study objectives. Failure to account for temporal variability may compromise the validity of study conclusions. The National Alachlor Well Water Survey is an example of a large-scale retrospective survey designed to estimate temporal averages of water quality. The well selection procedure grouped wells according to historical groundwater conditions (periods of historically high, moderate, and low groundwater recharge). (Tappert-PTT)
W90-07605

MICROCOMPUTER-AIDED PLANNING AT A HYDRO CONTROL CENTRE.
Tennessee Valley Authority, Norris. Engineering Lab.
For primary bibliographic entry see Field 6B.
W90-07610

OPTIMAL PUMPING TEST DESIGN FOR PARAMETER ESTIMATION AND PREDICTION IN GROUNDWATER HYDROLOGY.
California Univ., Los Angeles. Dept. of Civil Engineering.
J. M. McCarthy, and W. W. G. Yeh.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 779-791, April 1990. 10 fig, 7 tab, 8 ref. University of California, Water Resources Center Project UCLA-WRC-W-683.

Descriptors: *Aquifer testing, *Geohydrology, *Groundwater movement, *Pumping tests, *Well pumping, Aquifers, Decision making, Design criteria, Observation wells.

A systematic approach was developed to design a least cost aquifer pumping test. Systematic pumping test design evaluates the acceptability of all potential pumping test data sets, before actually performing the test. In this way, various acceptable pumping test designs can be compared in order to choose the least cost acceptable alternative. Delta identifiability is utilized as the acceptability criterion, such that, for a pumping test design to be acceptable, the parameters identified from the pumping test data set must predict some overall management objective within a prescribed error. The pumping test design problem is assumed to be a function of the number and location of the pumping and observation wells, as well as the pumping test pump rate, duration and measurement pattern. Using practical considerations and an evaluation of the pumping test design problems's response, the optimization problem is reduced to three decision variables: (1) the number of observation wells; (2) observation well locations, and (3) the pumping test pump rate. Values for the remaining decision variables are chosen and sensitivity analysis is used to evaluate their effects on the pumping test design problem. The pumping test design problem is decomposed into a main optimization problem and one subproblem. The main problem minimizes the number of observation wells by choice of their location, while the subproblem minimizes the pumping test pump rate subject to (1) a maximum pump rate, and (2) the delta identifiability constraint. (Author's abstract)
W90-07685

GLOBAL HYDROLOGIC AND ENERGY CYCLES: SUGGESTIONS FOR STUDIES IN THE PRE-GLOBAL ENERGY AND WATER CYCLE EXPERIMENT (GEWEX) PERIOD.
Maryland Univ., College Park. Dept. of Meteorology.
J. J. Kinter, and J. Shukla.
Bulletin of the American Meteorological Society BAMIAT, Vol. 71, No. 2, p 181-189, February 1990. 19 ref.

Descriptors: *Data requirements, *Energy, *Global Energy and Water Cycle Experiment,

*Hydrologic cycle, *Network design, Atmospheric circulation, Climatic data, Data acquisition, Earth Observing System Experiments, Seasonal variation, Tropical Rainfall Measuring Mission.

Given the importance of a quantitative understanding of the way water and energy are moved from place to place and from component to component of the earth's energy system, reliable estimates of the hydrologic and energy cycles in the global atmosphere are necessary. While a number of observing platforms designed to address this problem are anticipated in the coming decade, the theoretical and modeling concepts required to interpret the observations have not yet been well formulated. Therefore, the groundwork for making a reasonable estimate of the global hydrologic and energy cycles on time scales of one month to several years. A theoretical and modeling framework must be established in which the observations taken during the Global Energy and Water Cycle Experiment (GEWEX), the Tropical Rainfall Measuring Mission (TRMM), and the Earth Observing System Experiment (Eos) may be utilized. Future predictions of global general circulations will be reliable only if they can simulate the observed water and energy cycles. Only then can future predictions of water and energy processes also be considered accurate. Calculations of the seasonal cycle of water and energy fluxes between atmosphere and ocean, and between atmosphere and land may be carried out in four ways. First, the existing operational analyses of atmospheric data from the National Meteorological Center and the European Centre for Medium-Range Weather Forecasts for the most recent (and reliable) years of record may be used. Second, a set of reanalyzed data must be created from the historical record to broaden the database and to evolve an internally consistent, homogenous, and multivariate time series of climate observations. Third, a long integration of the most realistic, high-resolution general circulation models available should be made for comparison with the first two datasets in order to validate the model and identify and eliminate sources of systemic error. And, finally, when they become available, the calculations should be repeated based on observations taken during the GEWEX, TRMM, and Eos mission. (Author's abstract)
W90-07818

GROUNDWATER DISCHARGE TESTS: SIMULATION AND ANALYSIS.
For primary bibliographic entry see Field 2F.
W90-08153

GENERAL STATISTICAL PROCEDURE FOR GROUND-WATER DETECTION MONITORING AT WASTE DISPOSAL FACILITIES.
Illinois State Psychiatric Inst., Chicago.
R. D. Gibbons.
Ground Water GRWAAP, Vol. 28, No. 2, p 235-243, March/April 1990. 5 tab, 13 ref, append.

Descriptors: *Groundwater pollution, *Groundwater quality, *Parametric hydrology, *Statistical methods, *Waste disposal, Fate of pollutants, Monitoring wells, Probabilistic process, Water sampling.

To develop appropriate statistical methodology for evaluating the impact of waste disposal facilities on groundwater quality, nonparametric upper prediction limits for groundwater detection monitoring were defined as the maximum of a previous background sample of size n (i.e., X_{sub} (max,n)). The probability that at least one out of the next m measurements (i.e., Y_{sub} (min,m)) will be less than X_{sub} (max,n) at each of k monitoring wells is computed. In the context of groundwater monitoring, m is equal to the initial new measurement in a particular monitoring well plus m-1 resamplings of that well. In this way, values of n and m can be selected to assure a desired confidence level. Case studies have probabilities that were determined for values of n = 4 to 100, k = 1 to 100, and m = 1 to 3. It is possible to generalize to multiple variables (i.e., indicator parameters). (Author's abstract)
W90-08193

Group 7A—Network Design

RIVER WATER QUALITY: LOOKING INTO THE FOURTH DIMENSION.
R. A. J. Arthur.
Water & Waste Treatment Journal WWTJAA, Vol. 32, No. 2, p 41-47, February 1989. 4 fig.

Descriptors: *Computer models, *Pollution sources, *Water quality management, Rivers.

A computerized system developed in England by the Institute of Hydrology provides a conveniently packaged form of water management—a means to determine the fate of water flowing from any given point and instantly display the catchment area of water draining towards any point, as well as flood and low flow characteristics gleaned from historical data. The WIS (Water Information System) is a four-dimensional way of relating water authority information to some point in space or be expressed as time series data. In the first category it is possible to group places and items such as sewage works and rain gauges, as well as environmental features and facts relating to quality, such as pollution. These features can be considered to exist at a point; for system purposes they become spatial data. Time series data, grouped in the second category, include items such as daily flows, amounts of sewage needing treatment at particular times and all events identifiable either as causes or effects in relation to water quality, answering the question 'what is upstream or downstream from this point.' (Sand-PTT)
W90-08468

MAP3S CHEMISTRY AND DATA ANALYSIS.
Battelle Pacific Northwest Labs., Richland, WA.
M. T. Dana.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-009065. Price codes: A02 in paper copy, A01 in microfiche. Report No. PNL-SA--15821, April 1988. 8p, 2 fig, 2 tab, 4 ref. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Acid rain, *Data acquisition, *MAP3S Precipitation Chemistry Network, *Monitoring, *Precipitation, Air pollution, Databases, Information systems, Information transfer, Network design, Water pollution control.

The MAP3S Precipitation Chemistry Network (PCN) has operated since 1976 as the sole federally sponsored research sampling network. Many research projects have been conducted at the nine sites over the network's history, in addition to routine precipitation event sampling. The sampling, under consistent and quality controlled protocols, has provided a database for analyses of long-term trends in precipitation acidity, and for the evaluation of acidic deposition models. The objectives of the MAP3S/PCN are to: (1) coordinate sampling operations and maintain the separately funded network sites; (2) perform chemical analyses of the major ionic species in network samples; (3) manage and provide quality assurance for the resulting precipitation and annually to national databases; and (4) periodically report statistical summaries and special analyses of interest to the community. (Lantz-PTT)
W90-08564

7B. Data Acquisition

GROUNDWATER MONITORING: GUIDELINES AND METHODOLOGY FOR DEVELOPING AND IMPLEMENTING A GROUNDWATER QUALITY MONITORING PROGRAM.
Kaman Tempo, Santa Barbara, CA.
For primary bibliographic entry see Field 5A.
W90-07514

PROBLEMS AND ANALYTICAL METHODS FOR THE DETERMINATION OF TRACE METALS AND METALLOIDS IN POLLUTED AND NONPOLLUTED FRESHWATER ECOSYSTEMS.
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemie.
For primary bibliographic entry see Field 5A.

W90-07526

'ENCLOSURE' METHOD: CONCEPTS, TECHNOLOGY, AND SOME EXAMPLES OF EXPERIMENTS WITH TRACE METALS.
Commission of the European Communities, Ispra (Italy). Environmental Inst.
O. Ravera.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 249-272, 8 fig, 1 tab, 62 ref.

Descriptors: *Data acquisition, *Laboratory methods, *Toxicology, *Water pollution effects, Ecosystems, Experimental design, Experimental enclosures, Trace metals.

To predict the effects of pollution on an entire community from the results of laboratory experiments is rather uncertain. On the other hand, laboratory experiments are necessary: (1) to evaluate the potential toxicity of single pollutants and their mixtures; (2) to compare the relative toxicity of a series of chemicals suspected of being dangerous, and (3) to obtain basic information for legislation on environmental protection. These experiments are also useful for evaluating the reliability of hypotheses drawn from studies on polluted environments. Important results, often utilized to develop mathematical models, have been obtained by experiments carried out with polluted and nonpolluted 'balanced microcosms'. This method has some significant disadvantages due mainly to small sample size and variable temperature and light patterns. Conclusions from these studies must be drawn with great caution because the comparison is based on the assumption that similar environments must have similar communities. However, very useful information has been obtained from studies on natural experimentally polluted environments. One of the best methods for evaluating the effects of pollutants on populations and communities is the enclosure technique, which represents a compromise between laboratory experimentation and investigations in natural environments. The enclosure technique consists of isolating (generally by clear and flexible sheets of plastic material) two phases (water and sediment) representative of the entire ecosystem or one phase of it (for example, the water column without the underlying sediments). For pollution studies an enclosure is contaminated with a given toxic and another kept as control. The effects of pollution may be evaluated by comparing the variations of selected physical, chemical, and biological parameters within the contaminated enclosure and those observed in the control. The main advantages of the enclosure method include: (1) the initial characteristics within the enclosure are those of the natural ecosystem in which the experiment is carried out; (2) light and temperature are similar inside and outside the enclosure; (3) the enclosed ecosystem is, at least for a certain time, self-sustaining and always contains more trophic levels; (4) the enclosed ecosystem may be manipulated; and (5) the availability of the noncontaminated enclosure is kept as control. (See also W90-07522) (Lantz-PTT)
W90-07534

OUTDOOR PONDS: THEIR USE TO EVALUATE THE HAZARDS OF ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS.
Shell Research Ltd., Sittingbourne (England). Sittingbourne Research Centre.
For primary bibliographic entry see Field 5C.
W90-07535

ARTIFICIAL STREAMS IN ECOTOXICOLOGICAL RESEARCH.
Clemson Univ., SC. Dept. of Biological Sciences.
R. J. Kosinski.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume I. CRC Press, Boca Raton, Florida. 1989. p 297-316, 3 fig, 1 tab, 115 ref.

Descriptors: *Artificial watercourses, *Ecological effects, *Laboratory methods, *Toxicity, *Toxicology, Ecosystems, Experimental design, Model studies, Simulation analysis.

Predicting the effects of toxicants on the environment is very difficult. Due to historical, legal, and economic factors, most of the data which can be used for this task are derived from single-species tests, but it is clear that indirect effects can make toxicants more or less dangerous than predicted. One of the best ways to investigate these effects is with model ecosystems like artificial streams. Aside from the environmental control that can be exerted over these models, their great advantage is that they can be replicated. They are a powerful tool, but only when used with correct experimental design. While the statistical analysis of data and the interpretation of data can easily be redone if faulty, a trivial hypothesis, incorrect execution of procedures, or a bad experimental design can render data permanently unsalvageable. Experimental design has been the leading problem in gathering the expensive, hard-won data. Experimental design issues aside, artificial streams have made valuable contributions to ecotoxicology. Many researchers are asking the right questions about the correlation of model-ecosystem research with the field and with traditional single-species toxicology. Some studies on this question are encouraging, suggesting that the single-species/model-ecosystem approach is giving reliable results. Others raise doubts. Certainly, more studies are needed. The two best steps that could be taken to strengthen future toxicological artificial stream research are the replication of streams within treatments and more attempts to perform an integrated, comparative series of single-species, artificial stream, and field experiments. (See also W90-07522) (Lantz-PTT)
W90-07536

TROPHIC CHAINS AND EXPERIMENTAL ECOSYSTEMS: STUDY OF BIOACCUMULATION AND TRANSFER PROCESSES.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
For primary bibliographic entry see Field 5B.
W90-07538

STANDARDIZED AQUATIC MICROCOSM--DEVELOPMENT AND TESTING.
Washington Univ., Seattle. School of Fisheries.
For primary bibliographic entry see Field 5C.
W90-07539

SINGLE SPECIES TOXICITY TESTS.
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
For primary bibliographic entry see Field 5C.
W90-07540

FISH AS 'BIOLOGICAL MODEL' FOR EXPERIMENTAL STUDIES IN ECOTOXICOLOGY.
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie Fondamentale et d'Ecotoxicologie.
For primary bibliographic entry see Field 5C.
W90-07541

ECOTOXICITY TESTING USING AQUATIC BACTERIA.
Centre des Sciences de l'Environnement, Metz (France). Dept. of Microbiology.
For primary bibliographic entry see Field 5C.
W90-07543

LABORATORY AND FIELD TECHNIQUES IN ECOTOXICOLOGICAL RESEARCH: STRENGTHS AND LIMITATIONS.
National Fisheries Contaminant Research Center, Columbia, MO.
T. W. LaPoint, J. F. Fairchild, E. E. Little, and S. E. Finger.
IN: Aquatic Ecotoxicology: Fundamental Concepts and Methodologies. Volume II. CRC Press, Inc., Boca Raton, Florida. 1989. p 239-255, 2 fig, 1 tab, 92 ref.

Descriptors: *Ecotoxicology, *Experimental design, *Field tests, *Laboratory methods, *Toxi-

cology, *Water pollution effects, Costs, Literature review, Model studies, Path of pollutants.

Proponents of single-species laboratory tests have indicated that such procedures offer cost-effective, replicable, reproducible, and interpretable means of assessing chemical safety. Acute toxicity tests in the laboratory provide practical means for: (1) estimating effect concentrations of chemicals; (2) ranking chemicals for their relative toxicity; (3) evaluating the relative sensitivities of different organisms to a given chemical; and (4) evaluating the effects of water quality on chemical toxicity. Critics, have stated that single-species tests are inadequate for predicting the potential hazards of chemicals to aquatic life in complex ecosystems. Immigration, emigration, food resources, predator-prey relations, and competition are important factors on the ultimate environmental effects of contaminants; none of these factors are routinely simulated in standard single-species tests. Similarly, many physical, chemical, and biological factors can alter the amount, form, or availability of contaminants in the environment. Simple laboratory tests were not predictive where: (1) the chemical or environment was altered under actual exposure conditions, such as when acid deposition mobilized metals from sediments or when mercury is microbially methylated to the more toxic form; (2) the organisms could avoid a toxicant; or (3) secondary effects occurred due to alterations in grazing, competition, or predation resulting from the loss of a keystone species. Tests involving more complex environmental simulations were often successful in identifying these unpredictable results. The information gained in ecotoxicological testing adds to the basic knowledge of ecosystem structure and function. This addition is important, for the costs of such testing may be small when compared with the resultant expense of mitigating damage of toxicants in the environment for which the hazard has not been fully assessed. (See also W90-07537) (Lantz-PTT)
W90-07545

APPLIED ECOTOXICOLOGY AND METHODOLOGY.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5C.
W90-07547

APPLICATIONS OF WEATHER RADAR SYSTEMS: A GUIDE TO USES OF RADAR DATA IN METEOROLOGY AND HYDROLOGY.
Meteorological Office, Bracknell (England). Nowcasting and Satellite Applications Branch.
C. G. Collier.
John Wiley and Sons, New York, New York. 1989. 294p.

Descriptors: *Data acquisition, *Instrumentation, *Radar, *Remote sensing, *Weather, Hydrologic cycle, Hydrometeorology, Meteorology, Monitoring, Networks, Research priorities, Satellite technology, Weather forecasting.

The contribution made by weather radar data to the fields of meteorology, hydrology and the environmental sciences is considered, providing information on techniques of using weather radar data, together with an assessment of the success of such techniques in addressing particular problems. The main emphasis is on systems which can be applied operationally, with discussion of various meteorological research topics. Examples are drawn from a world-wide range of sources, noting regional differences and emphases. The many problems of meteorology which are of direct relevance to hydrology are also described. These problems are linked by the use of radar data to address them, and by their importance to a full understanding of the hydrological cycle. In addition to hydrometeorological applications how radar has improved the understanding of the way in which weather is produced, and how this knowledge is applied in operational systems is discussed. The need to develop robust operational radar networks means that consideration must be given not just to the radar itself, but also to real-time computing facili-

ties, to telecommunications and to the functions of the software producing the data. The contents are organized to take the reader from the basic theory of radar operation into the measurement of precipitation and how radar data are used with satellite data. The application of both radar and combined radar and satellite data to real-time weather and hydrological forecasting is discussed, followed by descriptions of the contribution radar data have made to civil engineering design, climatological studies and pollution monitoring. (Lantz-PTT)
W90-07549

WATER SAMPLING.
John Wiley and Sons, New York. 1989. 212p. Edited by Jaromil M. Krajca. Translation Editor–Jeremy Joseph.

Descriptors: *Data acquisition, *Data collections, *Sampling, *Water quality, *Water sampling, Groundwater, Measuring instruments, Precipitation, Rain, Sample preparation, Sample preservation, Snow, Soil water, Surface water.

Water forms a substantial and vital component of the environment in which we live. Sampling has been used to find out about the quality of natural waters for a long time. The most rudimentary form of sampling water is tasting it to find out whether it is suitable for drinking, i.e., testing it for taste and smell. The development of more technical sampling methods, coincided with the rise of interest in alchemy, natural medicine and the curative effects of bathing and medicinal waters. The subject of this book, however, is current and potential sampling methods and technology. In the general sense sampling includes all activities carried out to obtain a reliable picture of the state of the subject of study. The term 'sampling technique' covers the entire sampling operation, from the selection of sampling points to the delivery of samples for analysis. In all sampling programs it is necessary to: select the most suitable sampling equipment; decide at the outset which subsidiary measurements and observations will be needed; ensure the correct handling of the sampling equipment before, during and after sampling; ensure the correct handling of the samples; make provision for checking the samples, and for their preparation for analysis (mixing, sub-division, preservation, stabilization, filtration, etc.); and, make provision for transport and storage. Sampling technology embraces sampling instruments and equipment (samplers) in the widest sense, as well as instruments and devices used to take subsidiary measurements and observations, to retrieve stranded samplers or equipment, and to carry out regular testing, maintenance, etc. This broad definition holds for the sampling of all natural waters. The sequence in this book follows the natural circulation of water through the atmosphere, hydrosphere and lithosphere. Thus the chapter dealing with the general problems and common aspects of sampling precedes those on the sampling of atmospheric precipitation, surface water, soil water and groundwater. The scope and length of these chapters varies in relation to the varying conditions in the various aspects of sampling; it does not necessarily relate to the proportion of the various types of water in the relevant section of the hydrologic cycle, nor to their relative importance to life on earth. (Lantz-PTT)
W90-07553

SHORT-TERM METHODS FOR ESTIMATING THE CHRONIC TOXICITY OF EFFLUENTS AND RECEIVING WATERS TO FRESHWATER ORGANISMS. SECOND EDITION.
Environmental Monitoring Systems Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5C.
W90-07558

RELATION OF WIND FIELD AND BUOYANCY TO RAINFALL INFERRED FROM RADAR.
National Weather Service, Bohemia, NY. Eastern Region.
For primary bibliographic entry see Field 2B.
W90-07562

ON-LINE PRECONCENTRATION OF SILVER ON ACTIVATED ALUMINA AND DETERMINATION ON BOREHOLE WATER BY FLOW INJECTION ATOMIC ABSORPTION SPECTROPHOTOMETRY.
P. P. Coetzee, I. Taljaard, and H. de Beer.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 336, No. 3, p 201-204, February 1990. 7 fig, 1 tab, 14 ref.

Descriptors: *Alumina, *Atomic absorption spectrophotometry, *Chemical analysis, *Groundwater chemistry, *Laboratory methods, *Silver, *Well water, Analytical techniques, Boreholes, Detection limits, Flow injections, Water analysis.

A micro column of activated alumina in the basic form was used in conjunction with flame atomic absorption for the preconcentration and determination of silver in bore holewater. The silver was accumulated on the alumina column by pumping sample solution at pH 4 through the column at a rate of 5 cubic centimeters per minute for 5 minutes. By incorporating an injection valve and a simple interfacing device into the system, silver was determined by elution into the nebulizer of an atomic absorption spectrophotometer with 500 microliters of 2 mol/l nitric acid. Regeneration of the alumina to its basic form was achieved by 0.15 mol/L ammonia solution pumped through the column at 5 ml per minute for 2 minutes. A detection limit of 4 micrograms was measured, based on a sample volume of 25 milliliters. The relative standard deviation was less than plus or minus 5 percent at concentration levels above 10 microgram/L/. (Author's abstract)
W90-07568

MULTIFRACTALS, UNIVERSALITY CLASSES AND SATELLITE AND RADAR MEASUREMENTS OF CLOUD AND RAIN FIELDS.
McGill Univ., Montreal (Quebec). Dept. of Physics.
For primary bibliographic entry see Field 2B.
W90-07576

PARAMETER ESTIMATION AND SENSITIVITY ANALYSIS FOR THE MODIFIED BARTLETT-LEWIS RECTANGULAR PULSES MODEL OF RAINFALL.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
For primary bibliographic entry see Field 2B.
W90-07582

TWO-DIMENSIONAL STOCHASTIC-DYNAMICAL QUANTITATIVE PRECIPITATION FORECASTING MODEL.
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2B.
W90-07584

TUNED PERFECT PROGNOSIS FORECASTS OF MESOSCALE SNOWFALL FOR SOUTHERN ONTARIO.
Atmospheric Environment Service, Downsview (Ontario). Meteorological Services Research Branch.
For primary bibliographic entry see Field 2C.
W90-07585

ESTIMATION OF CONVECTIVE RAINFALL BY AREA INTEGRALS: 1. THE THEORETICAL AND EMPIRICAL BASIS.
For primary bibliographic entry see Field 2B.
W90-07587

RAIN ESTIMATION FROM SATELLITES: EFFECT OF FINITE FIELD OF VIEW.
Applied Research Corp., Landover, MD.
For primary bibliographic entry see Field 2B.
W90-07589

BEAM FILLING ERROR IN THE NIMBUS 5 ELECTRONICALLY SCANNING MICROWAVE RADIOMETER OBSERVATIONS OF GLOBAL ATLANTIC TROPICAL EXPERIMENT RAINFALL.
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-07590

SAMPLING ERRORS FOR SATELLITE-DERIVED TROPICAL RAINFALL: MONTE CARLO STUDY USING A SPACE-TIME STOCHASTIC MODEL.
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-07591

ESTIMATING THE EXCEEDANCE PROBABILITY OF RAIN RATE BY LOGISTIC REGRESSION.
Applied Research Corp., Landover, MD.
For primary bibliographic entry see Field 2B.
W90-07593

COMPARISONS OF THREE METHODS TO DETERMINE THE VERTICAL STRATIFICATION OF PORE FLUIDS.
Nevada Univ., Reno.
K. Taylor, J. Hess, A. Mazzella, and J. Hayworth.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 91-95, Winter 1990. 5 fig, 5 ref. EPA grant CR-812713.

Descriptors: *Data acquisition, *Groundwater movement, *Monitoring, *Path of pollutants, *Pollutant identification, *Sampling, *Stratified flow, *Tracers, Aquifer testing, Aquifers, Borehole geophysics, Conductivity, Interstitial water, Porosity, Test wells.

Three methods were used to investigate the possibility of vertical stratification of the pore fluid in an aquifer. The wells available for the study were fully screened and had a 5cm disturbed annulus around them. The first method used a pump with a straddle packer to isolate a short section of the screened interval. A tracer test demonstrated that most of the pumped sample came from the well bore, presumably by piping through the disturbed annulus. The second method used induction logs to measure the formation electrical conductivity as a function of depth. Due to the presence of clays and an inability to obtain porosity information, it was not possible to determine the pore fluid electrical conductivity using induction logs. A third method, dilution sampling, was developed that used a straddle packer to isolate a segment of the well screen. A tracer was injected into the packed-off segment, and the tracer concentration in the well was monitored. The tracer was removed from the packed-off segment by dilution and advection by ground water. When the tracer was completely removed from the packed-off segment, the fluid in the segment was considered to be representative of the adjacent pore fluid. Only the dilution sampling method determined unambiguously that the pore fluid was not stratified. (Author's abstract)
W90-07599

EFFECTS OF ACCESS TUBE MATERIAL AND GROUT ON NEUTRON PROBE MEASUREMENTS IN THE VADOSE ZONE.
Metcalf and Eddy, Inc., Santa Barbara, CA.
B. R. Keller, L. G. Everett, and R. J. Marks.
Ground Water Monitoring Review GWMRDU, Vol. 10, No. 1, p 96-100, Winter 1990. 5 fig, 8 ref. University of California at Santa Barbara/EPA Cooperative Agreement CR-813350-01.

Descriptors: *Borehole geophysics, *Data acquisition, *Grouting, *Monitoring, *Sampling, *Soil water, *Vadose zone, *Well casings, PVC, Pipes, Steel, Vadose water.

The use of the neutron moderation method of moisture detection for vadose zone monitoring is particularly appropriate in arid environments

where soil pore-liquid samples cannot be obtained. The effect of casing material and grout on the neutron probe measurements is important to properly install access tubes and interpret the results. A test-stand experiment was conducted on neutron probe measurements using steel and Schedule 40 PVC access tubes to determine the effect of backfill grout in boreholes. The experiment used a moveable simulated vadose zone. Access tubes and grout do have masking effects on vadose zone measurements, but vadose zone moisture was detected through all configurations tested. Steel tubing has a smaller masking effect than PVC tubing. A 6-inch hole backfilled with either volclay or cement/bentonite grout has a smaller marking effect than an 8-inch hole with the same grout. The effects of the two grout types on the neutron probe signature are similar. (Tappert-PTT)
W90-07600

MONITORING GROUND WATER FOR PESTICIDES AT A GOLF COURSE - A CASE STUDY ON CAPE COD, MASSACHUSETTS.
Horsley Witten Hegermann, Inc., Barnstable, MA.
For primary bibliographic entry see Field 5A.
W90-07601

COMPARISON OF OXIDATION-REDUCTION POTENTIALS CALCULATED FROM THE AS(V)/AS(III) AND FE(III)/FE(II) COUPLES WITH MEASURED PLATINUM-ELECTRODE POTENTIALS IN GROUNDWATER.
Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.
For primary bibliographic entry see Field 2K.
W90-07618

ELECTRODE MEASUREMENT OF REDOX POTENTIAL IN ANAEROBIC FERRIC/FERROUS CHLORIDE SYSTEMS.
Colorado School of Mines, Golden. Dept. of Chemistry and Geochemistry.
For primary bibliographic entry see Field 2K.
W90-07620

REGIONAL ANALYSES OF PRECIPITATION ANNUAL MAXIMA IN WASHINGTON STATE.
Washington State Dept. of Ecology, Olympia. Dam Safety Section.
For primary bibliographic entry see Field 2B.
W90-07644

DETERMINATION OF FRACTURE INFLOW PARAMETERS WITH A BOREHOLE FLUID CONDUCTIVITY LOGGING METHOD.
California Univ., Berkeley. Lawrence Berkeley Lab.
For primary bibliographic entry see Field 2F.
W90-07667

ESTIMATING STEADY INFILTRATION RATE TIMES FOR INFILTROMETERS AND PERMEAMETERS.
Guelph Univ. (Ontario). Dept. of Land Resource Science.
For primary bibliographic entry see Field 2G.
W90-07683

OPTIMAL PUMPING TEST DESIGN FOR PARAMETER ESTIMATION AND PREDICTION IN GROUNDWATER HYDROLOGY.
California Univ., Los Angeles. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W90-07685

DETECTION OF COLIFORM BACTERIA IN WATER BY POLYMERASE CHAIN REACTION AND GENE PROBES.
Louisville Univ., KY. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W90-07686

ENUMERATION AND BIOMASS ESTIMATION OF PLANKTONIC BACTERIA AND VI-

RUSES BY TRANSMISSION ELECTRON MICROSCOPY.
Bergen Univ. (Norway). Dept. of Microbiology and Plant Physiology.
K. Y. Borsheim, G. Bratbak, and M. Heldal.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 2, p 352-356, February 1990. 3 fig, 2 tab, 32 ref.

Descriptors: *Bacterial analysis, *Biomass, *Marine bacteria, *Microscopic analysis, *Plankton, *Viruses, Bacteriophage, Centrifugation, Coastal waters, Electron microscopy, Estimating, Population dynamics.

Bacteria and virus particles were harvested from water samples by ultracentrifugation directly onto Formvar-coated electron microscopy grids and counted in a transmission electron microscope. With this technique, bacteria and viruses were counted and sized in marine water samples and during laboratory incubations. By X-ray microanalysis, the elemental composition and dry-matter content of individual bacteria were determined. The dry weight/volume ratio for the bacteria was 600 fg of dry weight per cubic micrometer. The potassium content of the bacteria was normal compared with previous estimates from other bacterial assemblages; thus, this harvesting procedure did not disrupt the bacterial cells. Virus particles were, by an order of magnitude, more abundant than bacteria in marine coastal waters. During the first 5 to 7 days of incubation, the total number of viruses increased exponentially at a rate of 0.4/day and thereafter declined. The high proliferation rate suggests that viral parasitism may affect mortality of bacteria in aquatic environments high-resolution power and analytical possibilities give important information on both structure and changes in planktonic microbial assemblages down to the level of single particles in the nanometer size range. (Author's abstract)
W90-07688

ENUMERATION OF TOTAL COLIFORMS AND ESCHERICHIA COLI FROM SOURCE WATER BY THE DEFINED SUBSTRATE TECHNOLOGY.
Yale Univ., New Haven, CT. Dept. of Lab. Medicine.
For primary bibliographic entry see Field 5A.
W90-07689

BACTERIAL PRODUCTION AND GROWTH RATE ESTIMATION FROM (H3)THYMIDINE INCORPORATION FOR ATTACHED AND FREE-LIVING BACTERIA IN AQUATIC SYSTEMS.
Universidad del Pais Vasco, Bilbao (Spain). Dept. de Microbiologia e Inmunologia.
J. Iriberri, M. Unanue, B. Ayo, I. Barcina, and L. Egea.
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 2, p 483-487, February 1990. 48 ref, 2 tab.

Descriptors: *Aquatic bacteria, *Bacterial analysis, *Marine bacteria, Aquatic productivity, Biomass, Population dynamics, Stream biota.

Production and specific growth rates of attached and free-living bacteria were estimated in an oligotrophic marine system, La Salvaje Beach, Vizcaya, Spain, and in a freshwater system having a higher nutrient concentration, Butron River, Vizcaya, Spain. Production was calculated from (methyl-H3)thymidine incorporation by estimating specific conversion factors (cells or micrograms of carbon (C) produced per mole of thymidine incorporated) from attached and free-living bacteria, respectively, in each system. Conversion factors were not statistically different between attached and free-living bacteria: 681,200 and 867,800 g of C per mole for free-living and attached bacteria in the freshwater system, and 127,600 and 135,400 g of C per mole from free-living and attached bacteria in the marine system. Therefore, use of a unique conversion factor for the mixed bacterial population is well founded. However, conversion factors were higher in the freshwater system than in the

marine system. This could by due to the different trophic conditions of the two systems. Free-living bacteria contributed the most to production in the two systems (85% in the marine system and 67% in the freshwater system) because of their greater contribution to total biomass. Specific growth rates calculated from production data and biomass data were similar for attached and free-living bacteria. (Author's abstract)
W90-07692

NETWORK FOR LONG-TERM ECOLOGICAL RESEARCH IN THE UNITED STATES.
Wisconsin Univ.-Madison. Center for Limnology.
For primary bibliographic entry see Field 2H.
W90-07716

EXPERT SYSTEM FOR THE SELECTION OF A SUITABLE METHOD FOR FLOW MEASUREMENT IN OPEN CHANNELS.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-07724

USE OF STABLE ISOTOPE TRACERS FOR THE ESTIMATION OF THE DIRECTION OF GROUNDWATER FLOW.
For primary bibliographic entry see Field 2F.
W90-07732

METHOD FOR ESTIMATION OF PHYTOPLANKTON DARK LOSSES BY APPLICATION OF 14C-TECHNIQUES.
Akademie der Wissenschaften der DDR, Berlin. Inst. fuer Geographie und Geooekologie.
B. Nixdorf, and S. Fulda.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 445-450, 1989. 1 fig, 2 tab, 19 ref.

Descriptors: *Aquatic habitats, *Carbon cycle, *Carbon radioisotopes, *Limnology, *Photosynthesis, *Phytoplankton, *Primary productivity, *Respiration, Aquatic productivity, Carbon, Carbon dioxide, Dark fixation, Data acquisition, Diurnal variation, Food chains, Oxygen, Oxygen requirements.

In recent years it has become important to quantify losses from phytoplankton by investigating the relationship between primary production and concomitant biomass changes. It has been established that only a relatively small fraction of the carbon initially incorporated into organic pools by photosynthesis is transferred along the food chain. A method for estimation of respiratory losses of phytoplankton in the dark is described using application of the 14C-technique. Dark fixation of 14CO2 and excretion of labelled dissolved organic carbon are relatively low in comparison with primary production, but they have to be considered for the calculation of dark carbon loss. The influence of bacteria was investigated in the laboratory, while dark carbon loss in zooplankton was investigated in situ. These influences seem to be negligible. A comparison of oxygen consumption in the dark and dark carbon loss in the seasonal cycle resulted in a relatively constant carbon loss in the night (10.5 % of daily primary production), whereas oxygen consumption in the dark exceeded the dark carbon loss-values many times. (Mertz-PTT)
W90-07753

STABILIZATION OF GROWTH DURING COMBINED NITROGEN STARVATION OF THE PLANKTIC BLUE-GREEN ALGA ANABAENA SOLITARIA BY DINITROGEN FIXATION.
Humboldt-Univ. zu Berlin (German D.R.). Sektion Biologie.
J. G. Kohl, M. Schlangstedt, and G. Dudel.
Ergebnisse der Limnologie ERLIA6, Vol. 33, No. 2, p 457-464, 1989. 4 fig, 4 tab, 20 ref.

Descriptors: *Algal growth, *Anabaena, *Cyanophyta, *Limiting nutrients, *Nitrogen, *Nitrogen fixation, *Phytoplankton, *Solar radiation, Algae, Ammonium, Aquatic productivity, Food chains,

Growth, Growth rates, Irradiation, Light intensity, Light quality, Nitrates, Zooplankton.

Dependence of specific growth rate of the planktic blue-green alga Anabaena solitaria on irradiance is described using a modified Mitscherlich-equation. Deficiency of combined nitrogen only slightly influenced the maximum specific growth rate and the parameters of light utilization efficiency. Growth rates are at any irradiance only slightly lower. In comparison with ammonium-supplied cultures, algae cultivated with nitrate as sole nitrogen source show lower growth rates within the range of light limitation. Heterocysts are still present if combined nitrogen is supplied, even as ammonium. Only under strong light-limiting conditions does heterocyst frequency drop to nearly zero if ammonium is present. Under these light conditions heterocyst frequency in the presence of nitrate as sole combined nitrogen source is even higher than under complete deficiency of combined nitrogen. Comparing the light-utilization efficiency of growth, only Oscillatoria redekei outcompetes the other species by very high values. The high minimum light requirement for growth of Aphanizomenon flos-aquae results mainly from its colonial shape. It illustrates another ecological type of phytoplankter, which is well adapted to grow under high grazing pressure of filter-feeding crustacean zooplankton. (Mertz-PTT)
W90-07755

ESTIMATION OF MEAN RAIN RATE: APPLICATION TO SATELLITE OBSERVATIONS.
Maryland Univ., College Park. Dept. of Mathematics.
B. Kedem, L. S. Chiu, and G. R. North.
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 2, p 1965-1972, February 20, 1990. 2 fig, 4 tab, 23 ref.

Descriptors: *Data interpretation, *Rainfall distribution, *Rainfall rate, *Remote sensing, *Satellite technology, Statistical analysis, Statistical methods.

A method for the estimation of the mean area average rain rate from dependent data is developed and applied to the GARP Atlantic Tropical Experiment (GATE) data. The method consists of fitting a mixed distribution, containing an atom at zero, by minimum chi-square in combination with certain time-space sampling designs. In modeling the continuous component of the mixed distribution, the lognormal distribution provides a very close fit for the non-zero area average rain rates. A comparison with the gamma distribution shows that the lognormal distribution is a better choice as expressed by the minimum chi-square criterion. Some of the time-space sampling designs correspond to satellite sampling. The results indicate that a satellite visiting an area of about 350 by 350 sq km in the tropics approximately every ten hours, can provide a rather close estimate for the mean area average rain rate. (Author's abstract)
W90-07825

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MONTANA, OCTOBER 1987 THROUGH SEPTEMBER 1989.
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-07838

FIELD CONDITIONS AT THE MARICOPA AGRICULTURAL CENTER, PINAL COUNTY, ARIZONA, SEPTEMBER 28, 1989.
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 3F.
W90-07848

USING MINNOW TRAPS TO ESTIMATE FISH POPULATION SIZE: THE IMPORTANCE OF SPATIAL DISTRIBUTION AND RELATIVE SPECIES ABUNDANCE.
Wisconsin Univ.-Madison. Center for Limnology.
For primary bibliographic entry see Field 2H.
W90-07879

SIMPLE ELUTION AND RECONCENTRATION TECHNIQUE FOR VIRUSES CONCENTRATED ON MEMBRANE FILTERS FROM DRINKING WATER SAMPLES.
National Environmental Engineering Research Inst., Nagpur (India).
For primary bibliographic entry see Field 5A.
W90-07921

RESPIROMETER FOR CONTINUOUS, IN SITU, MEASUREMENTS OF SEDIMENT OXYGEN DEMAND.
Hong Kong Polytechnic, Kowloon. Dept. of Applied Science.
R. S. S. Wu.
Water Research WATRAG, Vol. 24, No. 3, p 391-394, March 1990. 2 fig, 11 ref.

Descriptors: *Measuring instruments, *Oxygen demand, *Respiration, *Sediment chemistry, Benthos, Respirometer.

The design of a respirometer for continuous, in situ measurement of sediment oxygen demand/benthic animal respiration is presented. The main parts of the respirometer consist of: (1) a plexiglass chamber (diameter: 12 cm; height: 30 cm) opened at one end (constructed from plexiglass tubing commercially available in various diameters and lengths); (2) a circular stabilizing plate (diameter: 70 cm) with lead weights, secured to the chamber by two jubilee clamps; (3) two suction diaphragm pumps; and (4) two oxygen electrodes mounted separately in two measuring chambers with stirrers. The plexiglass chamber is sealed at one end with a piece of plexiglass, to which the following three individually marked siphons are attached: (1) an inhalant siphon, allowing ambient water to enter the chamber; (2) an exhalant siphon for water to leave the chamber after passing over the surface of the sediment; and (3) a control siphon, for sampling water in the ambient environment. The major advantages of the design over the existing ones are: (1) ambient environmental conditions, particularly oxygen levels, can be maintained inside the chamber throughout a prolonged measurement period; (2) the design is simple and easy to deploy and provides continuous measurements over a wide, varying range of sediment oxygen demand (SOD); and (3) the existing problems in estimating 'optimal' chamber size to suit different SOD ranges and the undesirable effects of disturbing sediment by mixing devices inside the chamber are eliminated. Using the present design, the SOD of (1) a muddy bottom; (2) a sandy bottom; and (3) the organically enriched muddy bottom at a fish culture site were measured continuously for 6 h. The SOD of sandy, muddy and organically enriched muddy bottoms was found to be 21, 105 and 516 mg oxygen/sq m/hr, respectively. (Author's abstract)
W90-07925

MULTIVARIATE APPROACHES TO THE VARIATION IN PHYTOBENTHIC COMMUNITIES AND ENVIRONMENTAL VECTORS IN THE BALTIC SEA.
Stockholm Univ. (Sweden). Dept. of Zoology.
For primary bibliographic entry see Field 2L.
W90-07944

TOWARDS MONITORING DROUGHTS FROM SPACE.
Maryland Univ., College Park. Cooperative Inst. for Climate Studies.
For primary bibliographic entry see Field 2I.
W90-08005

NEW TYPE OF ZOOPLANKTON SAMPLER.
Biological Inst., Dubrovnik (Yugoslavia).
F. Krsinic.
Journal of Plankton Research JPLRD9, Vol. 12, No. 2, p 337-343, March 1990. 3 fig, 3 tab, 8 ref.

Descriptors: *Biological samples, *Coastal waters, *Samplers, *Zooplankton, Distribution patterns, Performance evaluation, Plankton nets, Population density.

A new, simple, and inexpensive sampler for quantitative sampling of zooplankton in shallow coastal waters is presented. It may be used from small research vessels with only a hand-operated winch. It can be used to investigate microdistribution patterns throughout the water column down to 50 cm above the seabed. The sampler consists of a metal ring with two semicircular cover plates and a bottom plate, of the same diameter, connected by a cylindrical gauze plankton net. The thin conical bottom plate has an opening in the middle to which a plastic plankton container is attached. Before use, the plates are positioned together, with the bottom plate in the upper position. After the cover plates open and the sampler has been lowered to the desired depth, the ring is released by a messenger and quickly extends the gauze cylinder. The cover plate then closes automatically. A second messenger releases the bottom plate, causing the sampler to turn upside down. With the plankton container now at the bottom, the sampler is lifted to the boat. In preliminary testing, a sampler with a 250-micron mesh cylinder was used to sample the mesozooplankton of an oligotrophic seawater lake. The same qualitative composition of mesozooplankton was observed in both Nansen net and plankton sampler samples but a marked discrepancy was observed between the abundances of the dominating species obtained by the two methods. Low coefficients of variation from 5.3-21.4% were determined for the species dominating in the 13-m depth layer from the samples taken with the plankton sampler. By sedimentation of 5 L Van Dorn bottle samples, reliable data for ciliates, developing copepod stages and small adult copepods were obtained, but not for mesozooplankton. (Sand-PTT)
W90-08011

PROGRAM PLAN AND SUMMARY--REMOTE FLUVIAL EXPERIMENTAL (REFLEX) SERIES: RESEARCH EXPERIMENTS USING ADVANCED REMOTE SENSING TECHNOLOGIES WITH EMPHASIS ON HYDROLOGIC TRANSPORT, AND HYDROLOGIC-ECOLOGIC INTERACTIONS.
Department of Energy, Washington, DC. Div. of Ecological Research.
Report No. DOE/ER-0254, October 1986. 67p, 17 fig, 2 tab, 52 ref, 2 append.

Descriptors: *Hydrologic systems, *Remote sensing, *Satellite technology, Ecosystems, Remote Fluvial Experiments, Research priorities, Watersheds.

The technology for aerial and satellite remote sensing has advanced rapidly over the past decade compared to the exploitation of these technologies for scientific experimentation. In particular, improvements in spectral discrimination, spatial resolution, and digital processing--among others--may contribute to understanding of natural processes in ways that are often difficult to anticipate. These new and emerging technological changes, the potential contributions of these changes to the natural sciences, motivate the Remote Fluvial Experiments (REFLEX) program. The goals of REFLEX are: (1) to apply new and developing aerial and satellite remote sensing technologies--including both advanced sensor systems and digital/optical processing--for interdisciplinary scientific experiments in hydrology and to hydrologic/ecologic interactions; (2) to develop new concepts for processing and analyzing remote sensing data for general scientific application; and (3) to demonstrate innovative analytical technologies that advance the state-of-the-art in applying information from remote sensing systems, for example, supercomputer processing and analysis. Four experiments are currently funded under the REFLEX program to address specific technical questions concerning hydrologic/ecologic processes. Research being conducted at Los Alamos National Laboratory to study surface hydrology and sediment transport in arid watersheds is discussed in Section 3. Section 4 describes investigations performed by Pennsylvania State Univ. to test hypotheses for watershed/landscape dynamics using digital analysis. Pacific Northwest Laboratory is testing hypotheses concerning ecologic/hydrologic processes in arid regions and these investigations are described in Sec-

tion 5. Section 6 gives the details of research being conducted by Pennsylvania State Univ. to study the hydrology of disturbed watersheds in humid regions. (Lantz-PTT)
W90-08164

MODEL-B SEDIMENT-CONCENTRATION GAGE: FACTORS INFLUENCING ITS READINGS AND A FORMULA FOR CORRECTING ITS ERRORS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
J. V. Skinner.
Report JJ, 1989. A Study of Methods Used in Measurement and Analysis of Sediment Loads in Streams. 34p, 15 fig, 3 tab, 11 ref.

Descriptors: *Gages, *Instrumentation, *Measuring instruments, *Sediment transport, Flow rates, Mathematical equations, Performance evaluation, Sediment concentration, Water pressure, Water temperature.

A gage for measuring suspended sediment concentration in flowing water was designed and tested. The gage contains a stationary, upstream-facing nozzle that guides a filament of the flow into a straight, slender tube. The tube vibrates continuously under control of magnets, coils, and electronic feedback circuits. A streamlined, waterproof shell serves as a protective housing for the tube and electronic components. The measuring principle is based on two relations: one linking sediment concentration to slurry density, and the other linking slurry density to vibrational period. As sediment concentration increases, the slurry density increases, and this, in turn, causes the tube's vibrational period to increase. Period readings can be converted to sediment-concentration values by using a calibration chart or an equation, but the first step is to minimize errors in the readings. Errors originate with: (1) shifts in dissolved-solids concentration, (2) water temperature, (3) water pressure, (4) flow rate, and (5) the amount of debris on the tube's walls. Of these five factors, the first three directly influence slurry density. Water temperature and water pressure can also influence vibrational periods by altering the tube's diameter. In certain situations, water temperature influences period readings by stretching or compressing the tube along its length. Flow rate exerts a mild influence on periods by creating Coriolis forces that press on the tube's walls. Debris on the walls alters period readings by changing the mass of the vibrating system. An equation for correcting the first four errors is presented, and an example of the data-reduction format is given. However, values of coefficients in the equation can be obtained only by installing a recording thermometer, a specific conductance meter, a staff gage, and a current meter. The thermometer must be exceptionally accurate and stable because the model-B gage is very sensitive to temperature shifts. In its present form, the gage will work best at sites where concentrations average > 1,000 mg/L. (Author's abstract)
W90-08166

DREAM: ANALYTICAL GROUNDWATER FLOW PROGRAMS.
B. Bonn, and S. Rounds.
Lewis Publishers, Chelsea, Michigan. 1990. 109p. Includes one 5-1/4-inch floppy disk containing the DREAM computer program.

Descriptors: *Aquifer testing, *Computer programs, *Groundwater movement, *Handbooks, *Pumping tests, Aquifers, Computer models, DREAM, Drawdown, Flow velocity, Groundwater level, Mathematical studies, Model studies.

DREAM is a user-friendly computer program for the IBM-PC that is designed to aid in the solution of simple groundwater problems. DREAM consists of four routines: Drawdown, Water Level Elevation, steady-state Velocity, and Steady-state Streamlines. The program is entirely menu-driven. The use provides aquifers and well field properties, defines a rectangular grid, and chooses a routine. DREAM calculates data at each grid point and writes that data to a file in the form of ordered triplets. All of the calculations in DREAM are

based upon analytical solutions which describe groundwater flow in a confined, homogeneous, isotropic aquifer of uniform thickness and infinite areal extent. Although the use of analytical solutions eliminates the errors associated with numerical methods, the inherent assumptions of the analytical models are severe and should be kept in mind when using DREAM. Although DREAM is very easy to use, the authors believe the documentation will be helpful to both expert and neophyte computer users. In the first three sections, they have addressed some fundamental issues including the necessary and desirable computer hardware and a general description of the program and its use. The Theory section contains all of the pertinent equations employed by DREAM. In the fifth section, Using DREAM, both an overview and a step-by-step detailed tutorial are presented. The Selected Examples section serves both as a means of quality control and a source of possible applications of DREAM. (Lantz-PTT)
W90-08171

GROUND WATER MODELING IN MULTI-LAYER AQUIFERS: STEADY FLOW.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-08172

BOREHOLE SITING IN CRYSTALLINE BASEMENT AREAS OF NIGERIA WITH A MICRO-PROCESSOR-CONTROLLED RESISTIVITY TRAVERSING SYSTEM.
Ibadan Univ. (Nigeria). Dept. of Geology.
A. Olayinka, and R. Barker.
Ground Water GRWAAP, Vol. 28, No. 2, p 178-183, March/April 1990. 9 fig, 15 ref.

Descriptors: *Borehole geophysics, *Computer models, *Geophysical exploration, *Geophysical methods, *Groundwater, *Resistivity, *Resistivity surveys, *Subsurface mapping, Contours, Cross-sections, Data acquisition, Data interpretation, Finite difference methods, Geologic fractures, Hydrologic data collections, Nigeria, On-site investigations, Weathering.

The Microprocessor-controlled Resistivity Traversing (MRT) System is a recent development which enables the acquisition of resistivity pseudo-section profile data under the control of a portable field computer. The system is used for groundwater investigations where water-bearing zones are overlain by thick overburden. A MRT system using the Wenner configuration has been developed to measure the distribution of resistivity in the subsurface down to depths of 200 meters. The data are presented as a contoured apparent resistivity cross-section, a type of electrical image, from which useful information about the structure of the subsurface can be obtained, such as weathering troughs, basement highs, and faults. Quantitative interpretation consists of iterative computer modeling using a two-dimensional finite difference method. Measurements conducted in Kwara State, Nigeria, in borehole siting surveys show that MRT surveys are an important aid in locating areas of deep weathering and fissure zones in structurally complex basement areas. The resistivity information obtained allows an appreciation of the subsurface structure which cannot be obtained easily with other geophysical techniques. (Author's abstract)
W90-08186

CHARACTERIZATION OF TRANSMISSIVE FRACTURES BY SIMPLE TRACING OF IN-WELL FLOW.
Whitman Companies, Inc., East Brunswick, NJ.
For primary bibliographic entry see Field 2F.
W90-08188

GENERAL STATISTICAL PROCEDURE FOR GROUND-WATER DETECTION MONITORING AT WASTE DISPOSAL FACILITIES.
Illinois State Psychiatric Inst., Chicago.
For primary bibliographic entry see Field 7A.

W90-08193

SAMPLING RADIUS OF A POROUS CUP SAMPLER: EXPERIMENTAL RESULTS.
Wisconsin Univ.-Madison. Dept. of Soil Science.
For primary bibliographic entry see Field 2F.
W90-08196

STUDIES OF PRECIPITATION PROCESSES IN THE TROPOSPHERE USING AN FM-CW RADAR.
Technische Hogeschool Delft (Netherlands). Faculty of Electrical Engineering, Telecommunication and Remote Sensing Technology.
For primary bibliographic entry see Field 2B.
W90-08199

SOURCES OF SAHEL PRECIPITATION FOR SIMULATED DROUGHT AND RAINY SEASONS.
National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies.
For primary bibliographic entry see Field 2B.
W90-08200

APPROXIMATE CALCULATION OF ADVECTIVE GAS-PHASE TRANSPORT OF 14C AT YUCCA MOUNTAIN, NEVADA.
Lawrence Livermore National Lab., CA. Earth Sciences Dept.
For primary bibliographic entry see Field 2G.
W90-08203

RELIABILITY ANALYSIS OF PUMPING SYSTEMS.
Chinese Academy of Environmental Sciences, Beijing.
For primary bibliographic entry see Field 8C.
W90-08211

STORM RUNOFF SIMULATION USING AN ANTECEDENT PRECIPITATION INDEX (API) MODEL.
Oregon State Univ., Corvallis. Dept. of Forest Engineering.
For primary bibliographic entry see Field 2E.
W90-08221

EVALUATION OF THE METHODS USED FOR THE DETERMINATION OF ORTHOPHOSPHATE AND TOTAL PHOSPHATE IN ACTIVATED SLUDGE EXTRACTS.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
For primary bibliographic entry see Field 5D.
W90-08232

SOME CONSIDERATIONS IN POLYPHOSPHATE DETERMINATIONS OF ACTIVATED SLUDGE EXTRACTS.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.
For primary bibliographic entry see Field 5D.
W90-08233

EFFECT OF SEDIMENT TEST VARIABLES ON SELENIUM TOXICITY TO DAPHNIA MAGNA.
Wright State Univ., Dayton, OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W90-08249

SIMPLE STOCHASTIC MODEL FOR ANNUAL FLOWS.
Marquette Univ., Milwaukee, WI. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-08276

BEHAVIOUR OF DIFFERENT ELUENTS AND STABILIZING AGENTS IN THE DETERMINA-

TION OF SULPHITE IN WATER BY ION-CHROMATOGRAPHY.
Rome Univ. (Italy). Dept. of Chemistry.
L. Campanella, M. Majone, and R. Pocci.
Talanta TLNTAZ, Vol. 37, No. 2, p 201-205, February, 1990. 2 fig, 4, tab, 17 ref.

Descriptors: *Analytical methods, *Chemical analysis, *Ion exchange chromatography, *Sulfites, *Water analysis, Analytical techniques, Oxidation, Pollution load, Quantitative analysis, Water pollution.

The use of ion-chromatography for the determination of sulfite in water was described. The eluents were solutions of sodium carbonate (1.1 millimolar)/sodium bicarbonate (1.4 millimolar) or sodium bicarbonate/formaldehyde (0.2% w/w). Formaldehyde, glycerol, or fructose was used as a stabilizing agent. With the sodium carbonate/sodium bicarbonate eluent, fructose or glycerol could be used to stabilize samples against sulfite oxidation, but formaldehyde affected the peak height. On the other hand, formaldehyde could stabilize sulfite in the presence of iron(III), whereas glycerol and fructose could not. In the presence of iron(III), the sodium bicarbonate/formaldehyde eluent was used and sulfite was eluted directly as hydroxymethanesulfonate; formaldehyde did not then affect the peak height. This eluent allowed a good peak separation and was suitable for the sulfite concentration range of 0.1 to 12.0 milligrams per liter. (Author's abstract)
W90-08294

SEQUENTIAL FRACTIONATION OF SEDIMENT PHOSPHATE.
Leiden Rijksuniversiteit (Netherlands). Dept. of Population Biology.
For primary bibliographic entry see Field 2K.
W90-08308

DETERMINATION OF AVAILABLE PHOSPHORUS FOR PHYTOPLANKTON POPULATIONS IN LAKES AND RIVERS OF SOUTH-EASTERN NORWAY.
Direktoratet for Vilt og Ferskvannsfisk, Trondheim (Norway).
For primary bibliographic entry see Field 2H.
W90-08319

MONITORING SYSTEMS FOR WATER QUALITY.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 5G.
W90-08320

TRIALS OF AN ACOUSTIC METHOD OF MEASURING PIEZOMETRIC LEVELS IN STANDPIPES.
Transport and Road Research Lab., Crowthorne (England). Overseas Unit.
W. Heath, and S. Dedi.
Hydrological Processes HYPRE3, Vol. 4, No. 1, p 35-43, January/March 1990. 6 fig, 11 ref.

Descriptors: *Acoustics, *Measuring instruments, *Piezometers, *Piezometric head, *Soil pressure, *Standpipes, Electrical equipment, Indonesia, Landslides, Monitoring, On-site data collections, Performance evaluation, Permeability, Soil porosity, Soil temperature.

The role of the open standpipe Casagrande piezometer for determining soil pressures is still important because of its simplicity and reliability in comparison with transducer-type instruments. Such factors are especially relevant when instrumentation is used on remote and inaccessible sites. The limitations of Casagrande type systems relate to poor response times, particularly in soils of low permeability, and the complexity of the normal gas bubbling equipment used to monitor and record data from this type of piezometer. The response can be improved, providing the design of the installation is taken into consideration in terms of the piezometer collection area and standpipe sizes. A simple acoustic technique has been developed to

monitor and record piezometric levels. This is based on measuring the period for the return echo of a high frequency signal: a technique widely used to focus cameras that has been found to be reliable and accurate. However, trials on landslide sites in Indonesia highlighted problems which related more to a lack of development rather than any fundamental problems in the method of monitoring standpipes. The main modifications to the system need to be as follows: (1) the transducers should be enclosed in containers that insulate the components and prevent the buildup of heat; (2) temperature measurements should be from within the standpipe and compensation is only necessary when there are temperature changes within the standpipe of more than 5 C; and (3) the standpipes should be made from a non-sound-absorbing material or lined with a thin metal tube that has close-fitting joints. (Author's abstract)
W90-08326

ANALYSIS OF SOLUTE TRANSPORT WITH A HYPERBOLIC SCALE-DEPENDENT DISPERSION MODEL.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5B.
W90-08327

DIAGNOSTIC TOOLS FOR SMALL HYDRO DEVELOPMENTS.
Agence Francaise pour la Maitrise de l'Energie, Paris.
For primary bibliographic entry see Field 8C.
W90-08332

DETERMINING INORGANIC DISINFECTION BY-PRODUCTS BY ION CHROMATOGRAPHY.
Environmental Monitoring Systems Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5F.
W90-08374

COMPARISONS BETWEEN ACOUSTIC MEASUREMENTS AND PREDICTIONS OF THE BEDLOAD TRANSPORT OF MARINE GRAVELS.
Proudman Oceanographic Lab., Birkenhead (England).
For primary bibliographic entry see Field 2J.
W90-08377

MEASUREMENT OF ELECTRON TRANSPORT SYSTEM ACTIVITY IN RIVER BIOFILMS.
University Coll. of North Wales, Bangor. School of Biological Sciences.
S. A. Blenkinsopp, and M. A. Lock.
Water Research WATRAG, Vol. 24, No. 4, p 441-445, April 1990. 2 fig, 1 tab, 24 ref.

Descriptors: *Analytical methods, *Biofilms, *Electron transport system, *Hydrobiology, *Microbiological studies, *Microorganisms, Assay, Methanol.

Factors that affect the measurement of electron transport system (ETS) activity in river biofilm through the reduction of 2-(p iodophenyl)-3-(p nitrophenyl)-5-phenyl tetrazolium chloride (INT) to iodonitrotetrazolium formazan (INT-formazan) were studied. Methanol extracts INT-formazan more effectively than either propanol or ethanol. A concentration of 0.02% INT was chosen and samples incubated for less than 8 hours. ETS activity is optimal at a circumneutral pH. ETS stimulators (NADH, NADPH and succinate) added as a check of the assay produced an increase in INT-formazan indicating that ETS activity was being measured. (Author's abstract)
W90-08385

Group 7B—Data Acquisition

ACCURACY OF THE EIKONAL TYPE AP-PROXIMATIONS FOR SIZING PARTICLES IN COHESIVE SEDIMENTS.
University Coll., Cardiff (Wales). Dept. of Physics.
S. K. Sharma, and D. J. Somerford.
Water Research WATRAG, Vol. 24, No. 4, p 447-450, April 1990. 4 fig, 10 ref.

Descriptors: *Analytical techniques, *Cohesive sediments, *Particle size, *Sediment analysis, Approximation method, Eikonal approximation, Erosion.

The problem of determining particle size using light scattering was examined. Biologically coated particles found in coherent sediment need to be sized because particle diameter is related to erosion as well as sedimentation. The extinction efficiency in the eikonal approximation and the anomalous diffraction approximation was compared with exact results for particles modeled as coated spheres. For a fixed particle radius a complete range of core radii was investigated. The size parameters and refractive indices chosen are typical of particles in cohesive sediments. These approximations reproduce the exact results to within 6% for particle size parameters greater than or equal to 100.00. Results clearly show that the approximations considered provide a very accurate description of the light scattered by particles of radius greater than 7.5 micrometer. For particles of radius between 0.75 and 7.5 micrometers, however, the description is only reasonably good. (Chonka-PTT)
W90-08386

EVALUATION OF AMMONIUM ION DETER-MINATION IN WATERS BY CATION EX-CHANGE ION CHROMATOGRAPHY OVER WIDE CONCENTRATION RANGES.
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
For primary bibliographic entry see Field 5A.
W90-08390

NUTRIENT AVAILABILITY AND THE ALGAL GROWTH POTENTIAL (AGP) IN A SMALL MICROCOSM.
Baylor Univ., Waco, TX. Dept. of Biology.
M. F. Taylor, W. J. Clark, and L. Ho.
Water Research WATRAG, Vol. 24, No. 4, p 529-532, April 1990. 2 fig, 9 ref.

Descriptors: *Algal growth, *Aquariums, *Bioassay, *Culturing techniques, *Laboratory methods, *Nutrients.

An aquarium microcosm was used to evaluate nutrient availability, for the algal growth potential (AGP) test, in samples containing varying degrees of particulate material. Samples were collected from a controlled aquatic microcosm before, during, and at the end of a simulated algal bloom. Nutrients shifted from the inorganic pool to the organic pool as the culture grew, resulting in nutrients being bound in refractory compounds not liberated by a prescribed autoclaving pretreatment. This, in turn, resulted in greater nutrient limitation in the algal assays as the particulate load (phytoplankton, bacteria, etc.) increased. It is demonstrated that the accepted pretreatment of autoclaving is relatively inefficient in releasing the nutrients from algal cells and converting them to a form usable by the algal assay organism. Since partitioning of nutrients between available and unavailable pools is highly variable in natural systems, this release problem, could have important implications in the interpretation of AGP studies, especially if other limnology parameters are not reported. In order to make the AGP test a more effective tool in characterizing the trophic state at various sampling times during the year, a more effective pretreatment would be most beneficial. (Author's abstract)
W90-08398

APPLICATION OF GEOPHYSICS IN THE DE-LINEATION OF THE FRESHWATER/SALINE-WATER INTERFACE IN THE MICHIGAN BASIN.
Geological Survey, Lansing, MI.

For primary bibliographic entry see Field 2F.
W90-08405

OHIO-INDIANA CARBONATE-BEDROCK AND GLACIAL REGIONAL AQUIFER SYSTEM ANALYSIS--PLAN OF STUDY.
Geological Survey, Columbus, OH.
For primary bibliographic entry see Field 2F.
W90-08406

HIGH PLAINS REGIONAL AQUIFER--ESTI-MATING 1980 GROUND-WATER PUMPAGE FOR IRRIGATION.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 4B.
W90-08411

PROTOZOAN BACTERIVORY IN ACIDIFIED WATERS: METHODS OF ANALYSIS AND THE EFFECT OF PH.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5C.
W90-08423

DIRECT DETECTION OF SALMONELLA SPP. IN ESTUARIES BY USING A DNA PROBE.
Center of Marine Biotechnology, Baltimore, MD.
For primary bibliographic entry see Field 5A.
W90-08427

DEVELOPMENT OF A SLOW SAND FILTER MODEL AS A BIOASSAY.
Institut fuer Wasserforschung, Dortmund (Germany, F.R.).
For primary bibliographic entry see Field 4B.
W90-08482

DEVELOPMENTS IN MODELLING SLOW SAND FILTRATION.
Thames Polytechnic, London (England).
For primary bibliographic entry see Field 5F.
W90-08490

MINIMIZATION OF VOLATILIZATION LOSSES DURING SAMPLING AND ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN WATER.
Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5A.
W90-08514

FIBER OPTIC METHODS FOR VOLATILE ORGANIC COMPOUNDS IN GROUNDWAT-ER.
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
W. Chudyk.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 87-99, 1 fig, 1 tab, 39 ref.

Descriptors: *Fiber optics, *Groundwater pollution, *Instrumentation, *Measuring instruments, *Pollutant identification, *Volatile organic compounds, *Water analysis, Costs, In situ tests, Monitoring, Organic compounds, Remote sensing, Spectroscopy.

Use of fiber optics to measure VOCs in groundwater allows real-time in situ measurements to be made, with accompanying advantages over conventional techniques: no need for chain-of-custody documentation; elimination of sample contamination during handling; no loss of volatiles from turbulence; no changes in pH from CO2 changes; no changes in Eh from O2 changes; and real-time results. In situ analysis of VOCs, primarily in groundwater applications, is following two major types of systems. Optrode systems provide specificity, at the expense of accuracy at high ionic strength levels and relatively short probe lifetime. Spectroscopic systems provide a wide range of

response and low cost, long-lived sensors, at the expense of selectivity. Both approaches have their applications and provide rapid answers useful in monitoring. As improvements are made in fiber optics and light sources, including lasers, it can be expected that these methods will find wider use. (See also W90-08509) (Lantz-PTT)
W90-08515

NATIONAL SURVEYS OF VOLATILE ORGAN-IC COMPOUNDS IN GROUND AND SURFACE WATERS.
Environmental Protection Agency, Cincinnati, OH. Water Supply Technology Branch.
J. J. Westrick.
IN: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Lewis Publishers, Inc., Chelsea, Michigan. 1990. p 103-125, 1 fig, 13 tab, 13 ref.

Descriptors: *Drinking water, *Groundwater pollution, *Surface water, *Surveys, *Volatile organic compounds, Data acquisition, Monitoring, Trihalomethanes, Water analysis.

The US EPA has been active in attempting to characterize the occurrence of synthetic volatile organic chemicals (VOCs) in drinking water since the late 1970s. National occurrence surveys advanced from the first pioneering study, the National Organic Reconnaissance Survey, which measured the concentrations of only two VOCs not formed by chlorination; through the National Organic Monitoring Survey, another survey with the principal emphasis on trihalomethanes, but with a longer list of analytes; through the Community Water Supply Survey, with improved methodology and quality assurance; and to the Ground Water Supply Survey, which was designed to specifically characterize with statistical validity the occurrence of many VOCs. Similarly, the quality of the data and the documentation of that quality improved as the techniques for analysis improved and more rigorous quality assurance concepts were implemented. From early surprise at finding VOCs in groundwater to accurate documentation of their frequent and sometimes high-level occurrence, the surveys have led to a better understanding of the significance of drinking water contamination by VOCs and have demonstrated quality assurance techniques applied to large-scale trace organics monitoring projects. The results of these surveys have resulted in a strong body of occurrence data upon which the decisions on regulations to control these compounds have been and will continue to be based. (See also W90-08509) (Lantz-PTT)
W90-08516

DETERMINATION OF AREAL EVAPOTRAN-SPIRATION FROM SATELLITE DATA USING A TEMPERATURE/SURFACE FLUXES IN-VERSION MODEL.
National Board of Waters, Helsinki (Finland).
Y. Sucksdorff, and C. Ottle.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Painatuskeskus, Helsinki, Finland. 1989. p 167-176, 6 fig, 1 tab, 12 ref.

Descriptors: *Atmospheric physics, *Evapotranspiration, *Finland, *Model studies, *Remote sensing, Atmospheric models, Hydrologic budget, Hydrologic models, Landsat, Satellite technology, Soil moisture, Synoptic analysis, Temperature, Vegetation effects.

A method for calculating areal evaporation by using synoptical weather data and satellite imagery is presented. Landsat images and digitized map data are used for calculating the land-use parameters. The nomalized difference vegetation index is calculated from satellite images. To estimate the surface temperature the data have to be corrected for atmospheric attenuation. The corrections are done with a radiative transfer model and atmospheric vertical profiles given by radiosounding. The surface temperature inversion methodology has been applied to estimate the surface fluxes and soil moisture in Finnish conditions for one month and it seems that the model works in a scale of

several hundreds of square kilometers and that it gives realistic estimates of soil moisture and areal surface fluxes from synoptical and satellite data. These output data can then be used as input to atmospheric or hydrological models. There was practically no difference in the cumulative evapotranspiration for July 1988 calculated by the model and calculated from water balance. One reason for this is that the model has worked in average conditions (leaf area index = 4 and three main soil types) and during a long period of time. In order to use the model for the purpose of following daily water budgets, and at a smaller scale, the vegetation and soil parameters must be known more accurately. (See also W90-08565) (Author's abstract)
W90-08576

LONG TERM INVESTIGATION OF THE RIVER DANUBE WATER QUALITY IN THE YUGOSLAV SECTION ACCORDING TO MICROBIOLOGICAL PARAMETERS.
Novi Sad Univ. (Yugoslavia). Inst. of Biology.
For primary bibliographic entry see Field 5C.
W90-08609

STUDIES ON THE CONTAMINATION STATUS OF THE DANUBE RIVER BASIN WATERS, MEASURES OF PROTECTION, AND RATIONAL EXPLOITATION OF THE WATER RESOURCES.
Institute for Biological Research, Belgrade (Yugoslavia). Dept. of Ichthyology.
For primary bibliographic entry see Field 5B.
W90-08610

AUTOMATIC WARNING STATIONS, RECENT SERIOUS INDUSTRIAL RIVER POLLUTION INCIDENTS, AND PREDICTION MODELS OF POLLUTANTS PROPAGATION-SOME EUROPEAN EXAMPLES.
Compagnie Generale des Eaux, Paris (France).
For primary bibliographic entry see Field 5A.
W90-08640

7C. Evaluation, Processing and Publication

AQUATIC ECOTOXICOLOGY: FUNDAMENTAL CONCEPTS AND METHODOLOGIES. VOLUME II.
For primary bibliographic entry see Field 5B.
W90-07537

MATHEMATICAL MODELS FOR PREDICTING THE FATE OF CONTAMINANTS IN FRESHWATER ECOSYSTEMS.
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 5B.
W90-07546

SOLUTION OF THE DAM-RESERVOIR INTERACTION PROBLEM USING A COMBINATION OF FEM, BEM WITH PARTICULAR INTEGRALS, MODEL ANALYSIS AND SUBSTRUCTURING.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W90-07557

MULTISCALING PROPERTIES OF SPATIAL RAINFALL AND RIVER FLOW DISTRIBUTIONS.
Cooperative Inst. for Research in Environmental Science, Boulder, CO. Center for the Study of Earth from Space.
For primary bibliographic entry see Field 2B.
W90-07574

CLUSTERED OR REGULAR CUMULUS CLOUD FIELDS: THE STATISTICAL CHARACTER OF OBSERVED AND SIMULATED CLOUD FIELDS.

Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 2B.
W90-07577

STABILIZATION FUNCTIONS OF UNFORCED CUMULUS CLOUDS: THEIR NATURE AND COMPONENTS.
Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 2B.
W90-07578

IN SEARCH OF REGULARITIES IN EXTREME RAINSTORMS.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 2B.
W90-07579

NUMERICAL SIMULATION OF THE AUGUST 1986 HEAVY RAINFALL EVENT IN THE SYDNEY AREA.
Bureau of Meteorology, Melbourne (Australia). Research Centre.
For primary bibliographic entry see Field 2B.
W90-07580

STATISTICAL MODEL OF EXTREME STORM RAINFALL.
McGill Univ., Montreal (Quebec). Dept. of Physics.
For primary bibliographic entry see Field 2B.
W90-07581

ESTIMATION OF MULTIDIMENSIONAL PRECIPITATION PARAMETERS BY AREAL ESTIMATES OF OCEANIC RAINFALL.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W90-07583

HYDROLOGIC MODELING OF NEW ENGLAND RIVER BASINS USING RADAR RAINFALL DATA.
Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
For primary bibliographic entry see Field 2B.
W90-07586

ESTIMATION OF CONVECTIVE RAINFALL BY AREA INTEGRALS: 2. THE HEIGHT-AREA RAINFALL THRESHOLD (HART) METHOD.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 2B.
W90-07588

VARIABILITY OF SUMMER FLORIDA RAINFALL AND ITS SIGNIFICANCE FOR THE ESTIMATION OF RAINFALL BY GAGES, RADAR, AND SATELLITE.
McGill Weather Radar Observatory, Ste. Anne de Bellevue (Quebec).
For primary bibliographic entry see Field 2B.
W90-07592

EXTREME RAINFALL IN CALDERDALE, 19 MAY 1989.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2B.
W90-07596

MONTE CARLO ANALYSIS AND BAYESIAN DECISION THEORY FOR ASSESSING THE EFFECTS OF WASTE SITES ON GROUNDWATER, I: THEORY.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5C.
W90-07614

INCORPORATING DAILY FLOOD CONTROL OBJECTIVES INTO A MONTHLY STOCHAS-

TIC DYNAMIC PROGRAMING MODEL FOR A HYDROELECTRIC COMPLEX.
British Columbia Hydro and Power Authority, Vancouver. System Operations and Maintenance Div.
D. J. Druce.
Water Resources Research WRERAQ, Vol. 26, No. 1, p 5-11, January 1990. 7 fig, 2 tab, 15 ref.

Descriptors: *Economic impact, *Economic justification, *Flood benefits, *Flood control, *Hydroelectric plants, *Model studies, *Reservoir operation, *Stochastic models, British Columbia, Hydrologic models, Peace River, Williston Lake.

A monthly stochastic dynamic programming model was recently developed and implemented at British Columbia (B.C.) Hydro to provide decision support for short-term energy exports and, if necessary, for flood control on the Peace River in northern British Columbia. The model establishes the marginal cost of supplying energy from the B.C. Hydro system, as well as a monthly operating policy for the G.M. Shrum and Peace Canyon hydroelectric plants and the Williston Lake storage reservoir. Inflow data are forecast using a conceptual hydrologic model developed at the University of British Columbia. Inflow forecasts are modeled based upon historical weather data and are updated monthly to indicate the change in runoff potential due to the weather that occurred in the previous month. A simulation model capable of following the operating policy then determines the probability of refilling Williston Lake and possible spill rates and volumes. Reservoir inflows are input to both models in daily and monthly formats. The results indicate that flood control can be accommodated without sacrificing significant export revenue. Use of the model reduces the probability of damaging spill rates and the occurrence of the worst spill rate. (Tappert-PTT)
W90-07634

EVALUATION OF VOLATILIZATION BY ORGANIC CHEMICALS RESIDING BELOW THE SOIL SURFACE.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-07635

KINETICALLY INFLUENCED TERMS FOR SOLUTE TRANSPORT AFFECTED BY HETEROGENEOUS AND HOMOGENEOUS CLASSICAL REACTIONS.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W90-07636

HYDROLOGIC SENSITIVITIES OF THE SACRAMENTO-SAN JOAQUIN RIVER BASIN, CALIFORNIA, TO GLOBAL WARMING.
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-07640

INVESTIGATION OF RADIAL DISPERSION-CAPACITANCE SYSTEM IN POROUS MEDIA.
Phillips Petroleum Co., Bartlesville, OK.
For primary bibliographic entry see Field 5B.
W90-07641

CONTAMINANT ACCUMULATION DURING TRANSPORT THROUGH POROUS MEDIA.
Los Alamos National Lab., NM.
For primary bibliographic entry see Field 5B.
W90-07642

STATISTICAL LOG PIECEWISE LINEAR MODEL OF AT-A-STATION HYDRAULIC GEOMETRY.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.

W90-07643

STOCHASTIC MODELING OF MACRODISPERSION IN HETEROGENEOUS POROUS MEDIA.
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-07645

APPLICATION OF A GUARANTEED REGRESSION MODEL TO TROPHIC INTERACTION IN AN AQUATIC SYSTEM.
South Bohemian Biological Centre, Ceske Budejovice (Czechoslovakia).
V. Krivan, and J. Seda.
Ecological Modelling ECMODT, Vol. 49, No. 1/2, p 1-6, December 1989. 4 fig, 3 ref.

Descriptors: *Data interpretation, *Fish, *Limnology, *Model studies, *Phytoplankton, *Zooplankton, Eggs, Mathematical studies, Regression analysis, Statistical models, Waterfleas.

The method of guaranteed estimation is used to estimate the unknown parameters of two nonlinear regression models. The first model examines the relations between the body size structure of zooplankton and the biomass of planktivorous fish. The second estimates time-lag between the dynamics of cladoceran egg production and dynamics of phytoplankton. An alternative method to statistical parameter estimation based on guaranteed estimation was developed. Contrary to conventional statistical approaches it, is assumed that no statistical data on the noise is available; it is only assumed that the noise is bounded. In the first case, the biomass of the planktivorous fish is taken as the independent variable and the proportion of the biomass of large cladocerans to the total biomass of zooplankton is the dependent variable. Since, for the computation, only annual averages for both variables can be used, only data for a 10-year period were available. This is not enough to validate the assumptions about the statistical properties of the noise. As another example, the data for the dynamics of cladoceran egg production and the dynamics of phytoplankton as a potential food source for cladocerans was used. It was assumed that these two time series are linearly dependent with added noise. The main difference between the method of guaranteed estimation and the other statistical methods for parameter estimation lies in the fact that in the case of zooplankton body size and planktivorous fish no statistical properties of the noise can be assumed. In the cladoceran egg production case, estimating three and more parameters makes the method of guaranteed estimation more difficult to use because it is difficult to visualize the admissible set. More advanced mathematical methods must be used. (Mertz-PTT)
W90-07651

SIMULATION MODELLING OF THE COASTAL WATERS POLLUTION FROM AGRICULTURAL WATERSHED.
Akademiya Nauk Estonskoi SSR, Tallinn. Inst. of Economics.
V. Krysanova, A. Meiner, J. Roosaare, and A. Vaselyev.
Ecological Modelling ECMODT, Vol. 49, No. 1/2, p 7-29, December 1989. 10 fig, 2 tab, 20 ref.

Descriptors: *Agricultural runoff, *Eutrophication, *Farm wastes, *Model studies, *Nitrogen, *Nonpoint pollution sources, *Path of pollutants, *Phosphorus, Agricultural watersheds, Data interpretation, Nutrients, Simulation analysis.

Nonpoint nutrient pollution from an agricultural watershed and its influence on the eutrophication process in a sea-bay ecosystem was analyzed by simulation modeling to determine nitrogen-loss and phosphorus-loss dynamics on the watershed and to evaluate the influence of excess nutrient flow on the sea-bay ecosystem. Discrete simulation was chosen as the level of approach for basin submodels to provide point-scale simulation of 501 areas of pollution. The practical results of the modeling confirm the existing opinion that there is not, and

cannot be, a single source of nonpoint pollution, the elimination of which would solve the problem. Even a number of measures (including in-soil application of fertilizers, replacement of a part of mineral fertilizers by manure, and water-protection belts) can yield only a 25% decrease in the nutrient loading if the doses of fertilizers remain unchanged. The problem is that the bulk of the nutrient washoff goes through the river system during short high-water periods, and is not subjected to biological transformation. Improvement of the situation is possible only by means of a number of measures both on the watershed area and in the bay. As a whole, though, the results obtained demonstrate the applicability and good prospects of a simulation technique for solving problems of environmental protection. (Mertz-PTT)
W90-07652

SIMULATION MODELLING OF THE EFFECTS OF OIL SPILLS ON POPULATION DYNAMICS OF NORTHERN FUR SEALS.
Applied Science Associates, Inc., Narragansett, RI.
For primary bibliographic entry see Field 5C.
W90-07654

MODELING VILLAGE WATER DEMAND BEHAVIOR: A DISCRETE CHOICE APPROACH.
Asian Development Bank, Manila (Philippines).
For primary bibliographic entry see Field 6D.
W90-07663

PRICING OF WATER RESOURCES WITH DEPLETABLE EXTERNALITY: THE EFFECTS OF POLLUTION CHARGES.
Institute of Socio-Economic Planning, University of Tsukuba, Tsukuba, Ibaraki, Japan.
For primary bibliographic entry see Field 6E.
W90-07664

OPTIMAL MULTICROP ALLOCATION OF SEASONAL AND INTRASEASONAL IRRIGATION WATER.
Indian Agricultural Research Inst., New Delhi. Water Technology Center.
For primary bibliographic entry see Field 3F.
W90-07666

ASYMPTOTIC EXPANSION FOR STEADY STATE OVERLAND FLOW.
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural and Biological Engineering.
For primary bibliographic entry see Field 2E.
W90-07668

MULTIVARIATE GEOSTATISTICAL APPROACH TO SPACE-TIME DATA ANALYSIS.
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
S. Rouhani, and H. Wackernagel.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 585-591, April 1990. 5 fig, 18 ref. NSF Grant INT-8702264.

Descriptors: *Data analysis, *Data interpretation, *Geohydrology, *Hydrologic models, *Space-time data analysis, Climatic variation, Seasonal variation, Spatial groupings, Steady state conditions, Temporal variation, Variograms.

A large number of hydrological phenomena may be regarded as realizations of space-time random functions. Most available hydrological data sets exhibit time-rich/space-poor characteristics, as well as, some form of temporal periodicity and spatial non-stationarity. To better understand the space-time structure of such hydrological variables, the observed values at each measurement site are considered as separate, but correlated time series. Moreover, it is assumed that the time series are realizations of a mixture of random functions, each associated with a different temporal scale, represented by a particular basic variogram. To preserve the observed temporal periodicities, the experimental direct and cross variograms are mod-

elled as linear combinations of a number of hole function variograms. In a further step, the principal component analysis is used to determine groupings of measurement stations at different temporal scales. The proposed procedure is then applied to monthly piezometric data in a basin south of Paris, France. The temporal scales are determined to be the 12-month seasonal and the 12-year climatic cycles. At each temporal scale different spatial groupings are observed which are attributed to the contrast between the nearly steady state climatic variations versus the almost transient seasonal fluctuations. (Author's abstract)
W90-07669

REAL-TIME CONTROL OF A SYSTEM OF LARGE HYDROPOWER RESERVOIRS.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
D. McLaughlin, and H. L. Velasco.
Water Resources Research WRERAQ, Vol. 26, No. 4, p 623-635, April 1990. 11 fig, 3 tab, 20 ref, append. NSF Grant ECE-8408369.

Descriptors: *Hydroelectric power, *Reservoir operation, *Watershed management, Algorithms, Power output, Real-time optimal control system, Reservoir releases, Venezuela.

A real-time optimal control approach for operating a system of large hydropower reservoirs was developed. The operating objective was to track specified power output targets, subject to a variety of physical constraints. The constraints describe the hydrologic behavior of the tributary watershed and the dynamics of the reservoir system. The decision variables are monthly average releases from each of the system reservoirs. These releases are derived in real time, as functions of available measurements of reservoir storage and tributary inflow. Inflow and measurement uncertainty are explicitly included in the state and measurement equations. The stochastic operations problem is first formulated in general terms and then simplified to allow the use of classical linear-quadratic stochastic control concepts. The solution to the simplified control problem is implemented by combining a linear deterministic control law with a linear estimation algorithm. The resulting stochastic controller is applied to a two-reservoir system in the Caroni River basin of Venezuela. Preliminary tests indicate that the controller performs well in this application, even when some of its underlying assumptions are violated. (Author's abstract)
W90-07672

OPTIMAL CONTROL METHOD FOR REAL-TIME IRRIGATION SCHEDULING.
Georgia Inst. of Tech., Atlanta.
For primary bibliographic entry see Field 3F.
W90-07674

STOCHASTIC APPROACH TO THE PROBLEM OF UPSCALING OF CONDUCTIVITY IN DISORDERED MEDIA: THEORY AND UNCONDITIONAL NUMERICAL SIMULATIONS.
Stanford Univ., CA. Dept. of Applied Earth Sciences.
For primary bibliographic entry see Field 2F.
W90-07677

STOCHASTIC DIFFERENTIAL EQUATION MODELS OF ERRATIC INFILTRATION.
Kentucky Univ., Lexington. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W90-07678

INSTABILITY OF HYDRAULIC GEOMETRY.
East Carolina Univ., Greenville, NC. Dept. of Geography and Planning.
For primary bibliographic entry see Field 2J.
W90-07681

HEAVY RAINFALL AT KHARTOUM ON 4-5 AUGUST 1988: A CASE STUDY.
Sudan Meteorological Dept., Khartoum (Sudan).
For primary bibliographic entry see Field 2B.
W90-07710

MODEL OF SURFACE WATER ACIDIFICATION IN CUMBRIA AND ITS USES IN LONG-TERM RESEARCH.
Freshwater Biological Association, Ambleside (England). Windermere Lab.
For primary bibliographic entry see Field 5B.
W90-07712

FIELD TEST OF A WATER BALANCE MODEL OF CRACKING CLAY SOILS.
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.
For primary bibliographic entry see Field 2G.
W90-07722

EVALUATION OF FACTORS AFFECTING RESERVOIR YIELD ESTIMATES.
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W90-07723

WINTER EVAPORATION ON A MOUNTAIN SLOPE, HAWAII.
Hawaii Univ., Honolulu. Dept. of Geography.
For primary bibliographic entry see Field 2D.
W90-07725

LONG-TERM WATER BALANCES FOR SUB-CATCHMENTS AND PARTIAL NATIONAL AREAS IN THE DANUBE BASIN.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 2A.
W90-07726

AUTOMATIC CaSCADE NUMBERING OF UNIT ELEMENTS IN DISTRIBUTED HYDROLOGICAL MODELS.
Universidad Autonoma Chapingo (Mexico). Dept. de Suelos.
W. Gandoy-Bernasconi, and O. Palacios-Velez.
Journal of Hydrology JHYDA7, Vol. 112, No. 3/4, p 375-393, January 1990. 8 fig, 15 ref.

Descriptors: *Geomorphology, *Hydrologic models, *Model studies, *Overland flow, *Rainfall-runoff relationships, *Routing, Cascade model, Digital Elevation Model, River flow, Slopes, Watersheds.

New procedures were developed to identify river-course networks in a Digital Elevation Model of a watershed. The procedures allow the assignment of a sequential number to each river-course segment that must be followed in a cascade algorithm to route the runoff through the watershed model, when the kinematic wave equation is going to be utilized. The developed algorithm also allows for the identification of the triangular planar units forming the contributing area of each river-course segment, as well as the assignment of a sequential number that must be followed in a cascade model in order to route the overland flow. The methodology has four parts: (1) analysis of the existing slope relationships between neighboring planes; (2) generation of a data structure for the river-course segment; (3) definition of the calculus sequence which must be followed by the river-course segments to route the runoff in a cascade model; and (4) definition of which triangular unit areas are constituents of the contributing area of each river-course segment. The computer code was tested using information from a small artificial and a large real watershed model. The results, concerning only the identification of the river-course and ridge networks, show agreement with known solutions. (Author's abstract)
W90-07731

CHARACTERISTICS OF CUMULUS BAND CLOUDS OFF THE COAST OF HAWAII.
Washington Univ., Seattle. Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-07735

DETERMINATION OF A Z-R RELATIONSHIP FOR SNOWFALL USING A RADAR AND HIGH SENSITIVITY SNOW GAUGES.
Hokkaido Univ., Sapporo (Japan). Inst. of Low Temperature Science.
Y. Fujiyoshi, T. Endoh, T. Yamada, K. Tsuboki, and Y. Tachibana.
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 2, p 147-152, February 1990. 7 fig, 4 tab, 19 ref.

Descriptors: *Instrumentation, *Precipitation gages, *Radar, *Remote sensing, *Snow accumulation, Mathematical studies, Reflectivity, Snow density, Storms.

Many attempts have been made to obtain radar reflectivity (Z) to snowfall rate (R) relationships. Two principal methods have been proposed to elucidate the relationships: Z-R relationships calculated only from surface observations of snow size distribution, without the use of radar data; or, the Z-R relationships obtained from radar data and from either measurements of snowfall intensity on the ground or the amount of snowfall estimated form snow depths. A best-fit power-law relationship between 1-minute integrated averages of r and z was determined on the basis of observations made using high sensitivity snow gages and radar of three 1987 Sapporo snowstorms. The relationship Z equals (554R (to the 0.88th power), using 30-minute integrated averages of Z and R, produced the best radar estimate of total snowfall. The ratio of the estimated to the observed amount of snowfall decreased with increasing density of new fallen snow rho, the ratio roughly equaling 1, when rho was about 0.005 gm/cu m. From these results, four important points are noted in determining a Z-R relationship at any given place: the local precipitation characteristics (especially the range and frequency distribution of precipitation intensity) should be studied; Z should be measured at intervals of one minute or less (the shorter the better); 30-minute integrated averages of Z and R should be used; and, the value of Z (not 10 log Z) should be used to calculate the integrated average of Z. (Brunone-PTT)
W90-07822

TESTS OF SELECTED SEDIMENT-TRANSPORT FORMULAS.
Iowa Inst. of Hydraulic Research, Iowa City.
For primary bibliographic entry see Field 2J.
W90-07830

TRANSPORT PREDICTION IN PARTIALLY STRATIFIED TIDAL WATER.
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
For primary bibliographic entry see Field 2L.
W90-07831

PROBLEMS WITH LOGARITHMIC TRANSFORMATIONS IN REGRESSION.
Maryland Univ., College Park. Dept. of Civil Engineering.
R. H. McCuen, R. B. Leahy, and P. A. Johnson.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 414-428, March 1990. 4 fig, 4 tab, 13 ref.

Descriptors: *Empirical models, *Mathematical models, *Power models, *Regression analysis, Bias, Least squares method, Numerical analysis.

The power model is widely used in engineering as the structure for empirical models. The coefficients are fitted using a logarithmic transformation of the data. The logarithmic transformation leads to a biased model, which is not usually corrected for. Even when the traditional approach to eliminating the bias is used, only the intercept coefficient is changed; the other coefficient are not corrected, so they remain biased estimators. A numerical method for fitting the coefficients of the power model enables the coefficients to be fit so they provide unbiased estimates and a minimum-error variance in the y-space, rather than the log y-space. The numerical method is easily modified to fit the coefficients using an objective function based on the relative errors. Examples using actual data are provided, e.g. debris flows in Los Angeles, and peak discharge data from Indiana. (Author's abstract)
W90-07833

SHORT-DURATION RAINFALLS IN ITALY.
Palermo Univ. (Italy). Ist. di Idraulica.
For primary bibliographic entry see Field 2B.
W90-07834

OBSERVATIONS OF OUTFLOWING JETS.
Ecole Polytechnique Federale de Lausanne (Switzerland). Dept. de Genie Civil.
For primary bibliographic entry see Field 8B.
W90-07836

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1987. VOLUME 1, GREAT LAKES AND SOURIS-RED-RAINY RIVER BASINS.
Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-182973. Price codes: A08 in paper copy, A01 in microfiche. USGS Water-Data Report MN-87-1 (WRD/HD-89/268), 1989. 148p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Minnesota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 45 gaging stations; stage-only records for 1 gaging station; stage and contents for 5 lakes and reservoirs; water quality for 13 stream stations and 2 partial-record lake stations; and water levels for 15 observation wells. Also included are 34 high-flow partial-record stations and 34 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data together with the data in Volume 2, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-07845) (USGS)
W90-07844

WATER RESOURCES DATA FOR MINNESOTA, WATER YEAR 1987. VOLUME 2, UPPER MISSISSIPPI AND MISSOURI RIVER BASIN.
Geological Survey, St. Paul, MN. Water Resources Div.
K. T. Gunard, J. H. Hess, J. L. Zirbel, and C. E. Cornelius.
Available from the National Technical Information Service, Springfield, VA 22161. USGS Water-Data Report MN-87-2 (WRD/HD-89/269), 1989. 311p. Prepared in cooperation with the State of Minnesota and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *Minnesota, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites,

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Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1987 water year for Minnesota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This volume contains discharge records for 55 gaging stations; stage and contents for 8 lakes and reservoirs; water quality for 14 stream stations, 1 lake station, 1 precipitation station, and 96 wells; and water levels for 136 observation wells. Also included are 75 high-flow partial-record stations and 93 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program and are published as miscellaneous measurements or low-flow investigations. These data together with the data in Volume 1, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Minnesota. (See also W90-07844) (USGS)
W90-07845

WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1988, VOLUME 1. EASTERN NEW YORK EXCLUDING LONG ISLAND.
Geological Survey, Albany, NY. Water Resources Div.
G. D. Firda, R. Lumia, and P. M. Burke.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-183096. Price codes: A12 in paper copy, A02 in microfiche. USGS Water-Data Report NY-88-1 (WRD/HD-89/287), 1989. 259p. Prepared in cooperation with the State of New York and with other agencies.

Descriptors: *Data collections, *Groundwater, *Hydrologic data, *New York, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in observation wells. This volume contains records of water discharge at 93 gaging stations; stage only at 4 gaging stations; and stage and contents at 4 gaging stations, and 19 other lakes and reservoirs; water quality at 37 gaging stations; and water levels at 25 observation wells. Locations of these sites are shown. Also included are data for 29 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program and are published as miscellaneous measurements. These data together with the data in Volumes 2 and 3, represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in New York. (See also W90-05263) (USGS)
W90-07846

WATER RESOURCES DATA FOR OREGON, WATER YEAR 1988, VOLUME 1. EASTERN OREGON.
Geological Survey, Portland, OR. Water Resources Div.
L. E. Hubbard, R. L. Moffatt, T. A. Herrett, R. L. Kraus, and G. P. Ruppert.
Available from the National Technical Information Service, Springfield, VA 22161, as PB90-183070. Price codes: A10 in paper copy, A02 in microfiche. USGS Water-Data Report OR-88-1 (WRD/HD-89/240), 1989. 208p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: *Data collections, *Hydrologic data, *Oregon, *Surface water, *Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1989 water year for Oregon consist of records of stage, discharge, and water quality of streams; and stage, contents, and

water quality of lakes and reservoirs. This report, in two volumes, contains discharge records for 250 gaging stations; stage only records for 7 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 44 stations; and water quality for 3 precipitation stations. Also included are 5 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-05260) (USGS)
W90-07847

PHYSICAL AND CHEMICAL DATA FROM TWO WATER-QUALITY SURVEYS OF STREAMS IN THE LEWISVILLE LAKE WATERSHED, NORTH-CENTRAL TEXAS, 1984 AND 1985.
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 5B.
W90-07850

GROUND-WATER SOURCES AND 1985 WITHDRAWALS IN FLORIDA.
Geological Survey, Tallahassee, FL. Water Resources Div.
C. S. Conover, J. Vecchioli, and D. W. Foose.
Available from Florida Geological Survey, 903 W. Tennessee Street, Tallahassee, FL 32304. Florida Geological Survey, Tallahassee, Map Series no. 124, 1989. 1 sheet (map), 3 fig, 1 tab, 18 ref. Project no. FL-075.

Descriptors: *Florida, *Groundwater, *Maps, *Water level, Water resources data.

More than 4 billion gal/day of groundwater are withdrawn from the five principal aquifers in the State. These aquifers are the Biscayne aquifer, the sand-and-gravel aquifer, unnamed surficial aquifers, an intermediate aquifer system, and the Floridan aquifer system. Groundwater is abundant, readily available, and generally of suitable quality for most uses. More than 64% of the 6,276 million gal/day of freshwater withdrawn for all purposes in Florida is groundwater. Almost 90% of Florida's public-supply and 100% of self-supplied rural-domestic withdrawals are from groundwater. Groundwater is the source of 55% of the water used for irrigation. Nationally, Florida ranks sixth among States in total fresh groundwater withdrawals for all uses, second for public supply, first for industrial uses, first for mining, and ninth for irrigation withdrawals. Groundwater use in Florida continues to increase as population increases, however, significant declines of groundwater levels have occurred in only a few local areas. In many areas, degradation of water has occurred in surficial deposits; and downward movement of contaminants is a possible threat to deeper aquifers. (USGS)
W90-07851

ESTIMATING FLOOD HYDROGRAPHS FOR ARKANSAS STREAMS.
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-07855

MISCELLANEOUS STREAMFLOW MEASUREMENTS IN THE STATE OF WASHINGTON, JANUARY 1961 TO SEPTEMBER 1985.
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-07858

FINITE ELEMENT SOLUTION OF THE SHALLOW-WATER WAVE EQUATIONS.
Norsk Hydroteknisk Lab., Trondheim.
T. Utnes.
Applied Mathematical Modelling AMMODL, Vol. 14, No. 1, p 20-29, January 1990. 18 fig, 29 ref.

Descriptors: *Data interpretation, *Finite element method, *Mathematical models, *Model studies, *Shallow water, *Waves, *Wind waves, Lake Mjosa, Lakes, Mathematical equations, Norway.

A finite element method is presented for the solution of the shallow-water wave equations. The method is characterized by a semi-implicit decoupling algorithm; the grid is composed of isoparametric, biquadratic elements, and the interpolation is mixed, with biquadratic velocity and bilinear elevation. The model was applied to a simulation of wind-induced internal waves in Lake Mjosa, demonstrating that the finite element formulation is well suited to describe the irregular geometry of the lake. The element flexibility makes it easy to modify special regions locally when necessary. The algorithm was designed to be cost-effective by minimizing the integration efforts, diagonalizing of the explicit part of the equations, factorizing the Helmholtz equation only once, and storing the constant global matrices. (Sand-PTT)
W90-07863

UNSTEADY RADIAL FLOW OF GAS IN THE VADOSE ZONE.
Colorado State Univ., Fort Collins. Dept. of Agricultural and Chemical Engineering.
For primary bibliographic entry see Field 5B.
W90-07906

FLOOD FREQUENCY ANALYSIS FOR THE 1988 TRURO FLOODS.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W90-07934

PRINCIPLES OF EVALUATION OF SOIL WATER RESIDENCE TIME USING QUEUEING DISCIPLINES WITH WATER BUDGET DATA (THEORETICAL BACKGROUND-I).
Kent State Univ., OH. Dept. of Geology.
For primary bibliographic entry see Field 2G.
W90-07975

METHOD FOR MODELING WATER TABLE AT DEBRIS AVALANCHE HEADSCARPS.
British Columbia Univ., Vancouver.
For primary bibliographic entry see Field 2J.
W90-07978

FLOOD ESTIMATION IN INDIAN CATCHMENTS.
Indira Gandhi National Open Univ., New Delhi (India).
R. J. Garde, and U. C. Kothyari.
Journal of Hydrology JHYDA7, Vol. 113, No. 1/4, p 135-146, February 1990. 4 fig, 2 tab, 16 ref, append 2.

Descriptors: *Catchment areas, *Flood forecasting, *Flood profiles, *India, Data processing, Flood peak, Land use, Rainfall, Slopes.

Data from 93 catchments in India were analyzed and include flood peaks, average rainfall values of different rainfall durations having a return period of 2 years, the coefficient of maximum monthly rainfall and the catchment characteristics represented by area, slope and land use. Out of the various frequency distributions tested, general extreme value type I was found to fit closely the annual flood peak series from Indian catchments. Relationships were proposed for the estimation of mean annual flood and the coefficient of variation of annual flood peak series. For 43 catchments the flood series had a length of minimum 20 years, hence the sampling error in the computation of the coefficient of variation should be small. The coefficient of variation of the annual peak flood series was found to vary with climatic conditions and the catchment area. (Author's abstract)
W90-07982

INFLUENCE OF GRID DISCRETIZATION ON THE PERCOLATION PROBABILITY WITHIN DISCRETE RANDOM FIELDS.
Notre Dame Univ., IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W90-07985

POWER-FUNCTION MODEL FOR THE SOIL MOISTURE CHARACTERISTIC.
Lincoln Coll., Canterbury (New Zealand). Dept. of Soil Science.
For primary bibliographic entry see Field 2G.
W90-07998

MODELLING MICROALGAL PRODUCTIVITY IN A HIGH RATE ALGAL POND BASED ON WAVELENGTH DEPENDENT OPTICAL PROPERTIES.
Amsterdam Univ. (Netherlands). Lab. voor Microbiologie.
For primary bibliographic entry see Field 5D.
W90-08001

EFFECT OF TROPICAL ATLANTIC ANOMALIES UPON GCM RAIN FORECASTS OVER THE AMERICAS.
Universidade Federal do Rio de Janeiro (Brazil). Dept. of Meteorology.
For primary bibliographic entry see Field 2B.
W90-08003

COUNTING ERROR AND THE QUANTITATIVE ANALYSIS OF PHYTOPLANKTON COMMUNITIES.
Instituto de Ciencias del Mar, Barcelona (Spain).
C. M. Durante, C. Marrase, D. Vaque, and M. Estrada.
Journal of Plankton Research JPLRD9, Vol. 12, No. 2, p 295-304, March 1990. 6 fig, 25 ref. CAYCIT grant no. 3246/79.

Descriptors: *Cell counting, *Error analysis, *Harbors, *Phytoplankton, *Population dynamics, Algae, Biomass, Counting error, Masnou harbor, Spain, Species diversity, Succession, Uncertainty.

An investigation of the phytoplankton community in Masnou harbor, Barcelona, Spain, establishes that phytoplankton counting error decreases with increasing biomass. When combining the individual density estimates to yield a single figure, error propagation introduces great uncertainty around succession and diversity indices. Furthermore, counting error increases the value of succession indices for communities where all species change at the same rate above the expected value of 0. Consequently, conclusions based on the comparison of succession and diversity indices should only be drawn when the uncertainty derived from counting error is considered. (Author's abstract)
W90-08009

PERFORMANCE OF A NEW ECOTOXICOLOGICAL INDEX TO ASSESS ENVIRONMENTAL IMPACTS ON FRESHWATER COMMUNITIES.
Instituto Nacional de Investigaciones Agrarias, Madrid (Spain). Centro de Investigacion y Tecnologia.
For primary bibliographic entry see Field 5C.
W90-08020

DIATOM QUALITY CONTROL AND DATA HANDLING.
University Coll., London (England). Palaeoecology Research Unit.
For primary bibliographic entry see Field 2H.
W90-08101

DIATOMS AND PH RECONSTRUCTION.
Bergen Univ. (Norway). Botanical Inst.
For primary bibliographic entry see Field 2H.
W90-08102

MODELLING LONG-TERM ACIDIFICATION: A COMPARISON WITH DIATOM RECONSTRUCTIONS AND THE IMPLICATIONS FOR REVERSIBILITY.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2H.
W90-08124

GROUNDWATER DISCHARGE TESTS: SIMULATION AND ANALYSIS.
For primary bibliographic entry see Field 2F.
W90-08153

LOGS OF WELLS AND BOREHOLES DRILLED DURING HYDROGEOLOGIC STUDIES AT LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300. JUNE 1, 1982-JUNE 30,1988.
Brown and Caldwell, Pleasant Hill, CA.
K. C. Toney, and N. B. Crow.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-012303. Price codes: A17 in paper copy, A01 in microfiche. Report No. UICD--21536, (1989). 351p.

Descriptors: *Computer programs, *Drillers logs, *Groundwater pollution, *Path of pollutants, *Well logs, Geohydrology, Tritium, Volatile organic compounds, Wells.

The geohydrologic well logs for monitor wells and exploratory boreholes drilled at Lawrence Livermore National Laboratory (LLNL) Site 300 between the beginning of environmental investigations in June 1982 and the end of June 1988, are presented. These wells and boreholes were drilled as part of studies made to determine the horizontal and vertical distribution of volatile organic compounds (VOCs), high explosive (HE) compounds, and tritium in soil, rock, and groundwater at Site 300. The well logs for 293 installations comprise the bulk of this report. A commercially available computer program, LOGGER, has been used since late 1985 to generate these logs. This report presents details of the software programs and the hardware used. (Lantz-PTT)
W90-08155

COMPILATION OF HYDROLOGIC DATA FOR THE EDWARDS AQUIFER, SAN ANTONIO AREA, TEXAS, 1988, WITH 1934-88 SUMMARY.
Geological Survey, San Antonio, TX. Water Resources Div.
G. M. Nalley.
Bulletin 48, November 1989. 157p, 8 fig, 5 tab, 4 append.

Descriptors: *Edwards Aquifer, *Groundwater budget, *Groundwater recharge, *Hydrologic data collections, Aquifers, Data collections, Flow discharge, Texas, Water quality, Water use.

The average estimated annual groundwater recharge to the Edwards aquifer in the San Antonio area, Texas, from 1934 through 1988 was 635,000 acre-ft. Recharge in 1988 was 355,500 acre-ft, which is the fifteenth smallest estimated annual recharge since 1934. The maximum annual recharge of 2,003,600 acre-ft occurred in 1987, and a minimum annual recharge of 43,700 acre-ft occurred in 1956. The calculated annual discharge from the Edwards aquifer by wells and springs in 1988 was 926,400 acre-ft, which is the third largest calculated annual discharge since 1934. Annual discharge by wells and springs ranged from a maximum of 960,900 acre-ft in 1977 to a minimum of 388,800 acre-ft in 1955. Water levels in many of the wells during 1988 fluctuated above to near the mid-point between record high and low levels, reflecting an above to near average volume of groundwater in storage in the aquifer during most of the year. In 1987, substantial increases occurred during the late spring and early summer, after which water levels remained above average in most of the area. Water levels then remained above to near average throughout 1988. Analyses of water samples from 56 wells and 3 springs in the Edwards aquifer show that the water quality in the freshwater zone is significantly better than the

level established for public water systems. However, trace concentrations of organic compounds were detected in many of the analyses. In 1988, samples were collected and analyzed from wells transecting the 'bad-water' line and no significant changes in water quality were detected as the potentiometric head in the Edwards aquifer changed. (Author's abstract)
W90-08160

PROGRAM PLAN AND SUMMARY--REMOTE FLUVIAL EXPERIMENTAL (REFLEX) SERIES: RESEARCH EXPERIMENTS USING ADVANCED REMOTE SENSING TECHNOLOGIES WITH EMPHASIS ON HYDROLOGIC TRANSPORT, AND HYDROLOGIC-ECOLOGIC INTERACTIONS.
Department of Energy, Washington, DC. Div. of Ecological Research.
For primary bibliographic entry see Field 7B.
W90-08164

DREAM: ANALYTICAL GROUNDWATER FLOW PROGRAMS.
For primary bibliographic entry see Field 7B.
W90-08171

MODELING OF GROUND-WATER CONTAMINATION CAUSED BY ORGANIC SOLVENT VAPORS.
Waterloo Univ. (Ontario). Inst. for Ground Water Research.
For primary bibliographic entry see Field 2F.
W90-08189

COMPATIBLE SINGLE-PHASE/TWO-PHASE NUMERICAL MODEL: 2. APPLICATION TO A COASTAL AQUIFER IN MEXICO.
Ecole Nationale Superieure des Mines de Paris, Fontainebleau (France). Centre d'Information Geologique.
For primary bibliographic entry see Field 2F.
W90-08191

OASIS: A GRAPHICAL DECISION SUPPORT SYSTEM FOR GROUND-WATER CONTAMINANT MODELING.
Groundwater Services, Inc., Houston, TX.
For primary bibliographic entry see Field 5B.
W90-08192

ANALYSIS OF THE THRESHOLD METHOD FOR MEASURING AREA-AVERAGE RAINFALL.
Maryland Univ., College Park. Dept. of Mathematics.
For primary bibliographic entry see Field 2B.
W90-08197

HARMONIC ANALYSIS OF THE SEASONAL CYCLE IN PRECIPITATION OVER THE UNITED STATES: A COMPARISON BETWEEN OBSERVATIONS AND A GENERAL CIRCULATION MODEL.
State Univ. of New York at Stony Brook. Inst. for Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W90-08201

INTERFACIAL MIXING IN ESTUARIES AND FJORDS.
Polytechnic of Wales, Pontypridd. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-08208

DETAILED DELIMITATION OF RAINFALL REGIONS IN SOUTHERN AFRICA.
Natal Univ., Pietermaritzburg (South Africa). Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2B.
W90-08226

Field 7—RESOURCES DATA

Group 7C—Evaluation, Processing and Publication

THUNDERSTORM CLIMATOLOGICAL RE-
SEARCH IN GREAT BRITAIN AND IRELAND:
A PROGRESS REPORT AND AIMS FOR
FUTURE STUDY.
Tornado and Storm Research Organisation, Cor-
sham (England). Thunderstorm Div.
For primary bibliographic entry see Field 2B.
W90-08235

QSARS BASED ON STATISTICAL DESIGN
AND THEIR USE FOR IDENTIFYING CHEMI-
CALS FOR FURTHER BIOLOGICAL TESTING.
Istituto Superiore di Sanita, Rome (Italy). Lab. di
Tossicologia Comparata ed Ecotossicologia.
For primary bibliographic entry see Field 5C.
W90-08240

PHYSICALLY BASED FLOOD FEATURES
AND FREQUENCIES.
California Univ., Berkeley. Dept. of Civil Engi-
neering.
For primary bibliographic entry see Field 2E.
W90-08253

FRICTION FACTOR OF ARMORED RIVER
BEDS.
Colorado State Univ., Fort Collins. Dept. of Civil
Engineering.
For primary bibliographic entry see Field 2J.
W90-08255

BED EVOLUTION IN CHANNEL BEDS.
National Taiwan Univ., Taipei. Dept. of Civil En-
gineering.
For primary bibliographic entry see Field 2J.
W90-08256

LEAST-SQUARES PARAMETER ESTIMATION
FOR MUSKINGUM FLOOD ROUTING.
Princeton Univ., NJ. Dept. of Civil Engineering
and Operations Research.
For primary bibliographic entry see Field 2E.
W90-08258

COMPUTING PHASE SPEEDS AT OPEN
BOUNDARY.
Institute for Naval Oceanography, Stennis Space
Center, MS.
For primary bibliographic entry see Field 2L.
W90-08260

NUMERICAL SIMULATIONS OF BLUE CRAB
LARVAL DISPERSAL AND RECRUITMENT.
Minerals Management Service, Herndon, VA. En-
vironmental Studies Branch.
For primary bibliographic entry see Field 2L.
W90-08264

SIMPLE STOCHASTIC MODEL OF HOURLY
RAINFALL FOR FARNBOROUGH, ENGLAND.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2B.
W90-08266

APPRAISAL OF THE 'REGION OF INFLU-
ENCE' APPROACH TO FLOOD FREQUENCY
ANALYSIS.
Manitoba Univ., Winnipeg. Dept. of Civil Engi-
neering.
For primary bibliographic entry see Field 2E.
W90-08267

SUITABILITY OF TWO-PARAMETER
GAMMA AND THREE-PARAMETER BETA
DISTRIBUTIONS AS SYNTHETIC UNIT HY-
DROGRAPHS IN ANATOLIA.
Cukurova Univ., Adana (Turkey). Dept. of Civil
Engineering.
T. Haktanir, and N. Sezen.
Hydrological Sciences Journal HSJODN, Vol. 35,
No. 2, p 167-184, April 1990. 6 fig, 4 tab, 10 ref.

Descriptors: *Data interpretation, *Hydrograph
analysis, *Turkey, *Unit hydrographs, Anatolia,
Flood hydrographs, Probability distribution.

Unit hydrograph (UF) theory is widely used in
computing design flood hydrographs. Due to lack
of sufficient data in developing countries, unit hy-
drographs must often be computed by synthetic
methods. The scale-adjusted probability density
functions of the two-parameter gamma and the
three-parameter beta distributions were shown to
fit reasonably well to 10 observed unit hydro-
graphs in Anatolia, the gamma exhibiting slightly
better fits. The gamma synthetic UH can be appli-
cable to watersheds of sized from 10-10,000 sq km.
It is not suitable to those UH's having wedge-like
sharp peaks. Regression equations for peak flow
rate and lag time for the data of these 10 sample
watersheds were computed. As a result, a BASIC
computer program was developed for standard PC
computers, which first computes the ordinates of
the gamma synthetic UH, given some watershed
characteristics, excess rainfall duration, and time
interval. It then draws the UH to scale. (Author's
abstract)
W90-08268

DERIVATION OF AN EXPLICIT EQUATION
FOR INFILTRATION ON THE BASIS OF THE
MEIN-LARSON MODEL.
Technische Univ., Vienna (Austria). Inst. fuer Hy-
draulik Gewasserkunde und Wasserwirtschaft.
For primary bibliographic entry see Field 2E.
W90-08270

ESTIMATION OF GROUNDWATER RE-
CHARGE FROM SPRING HYDROGRAPHS.
State Hydraulic Works, Ankara (Turkey). Geo-
technical Services and Groundwater Div.
For primary bibliographic entry see Field 2F.
W90-08271

ESTIMATING UNCERTAINTY OF STORM-
WATER RUNOFF COMPUTATIONS.
Texas Univ. at Dallas, Richardson. Inst. for Envi-
ronmental Sciences.
For primary bibliographic entry see Field 4C.
W90-08274

CALIBRATION OF SWMM RUNOFF QUAL-
ITY MODEL WITH EXPERT SYSTEM.
For primary bibliographic entry see Field 2E.
W90-08278

GEOMORPHOLOGIC RAINFALL-RUNOFF
MODEL: INCORPORATING PHILIP'S INFIL-
TRATION EXPRESSION.
Cairo Univ., Giza (Egypt). Dept. of Irrigation and
Hydraulics.
For primary bibliographic entry see Field 2B.
W90-08279

PROCESSES OF MARINE DISPERSAL AND
DEPOSITION OF SUSPENDED SILTS OFF
THE MODERN MOUTH OF THE HUANGHE
(YELLOW RIVER).
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 2J.
W90-08323

MODEL TESTS OF THE URFA TUNNEL
SYSTEM IN TURKEY.
Technical Univ. of Istanbul (Turkey). Dept. of
Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-08338

SIMULATION OF CHEMICAL TRANSPORT
IN UNSATURATED SOIL.
Bechtel Environmental, Inc., Oak Ridge, TN.
For primary bibliographic entry see Field 5B.
W90-08340

AUTOMATED CALIBRATION AND USE OF
STREAM-QUALITY SIMULATION MODEL.

CH2M Hill, Inc., Atlanta, GA.
For primary bibliographic entry see Field 5B.
W90-08341

STATISTICAL EVALUATION OF MECHANIS-
TIC WATER-QUALITY MODELS.
Duke Univ., Durham, NC. School of Forestry and
Environmental Studies.
For primary bibliographic entry see Field 5B.
W90-08342

DECOMPOSITION OF LARGE WATER-DIS-
TRIBUTION SYSTEMS.
Roorkee Univ. (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-08343

COLLOID REMOVAL IN FLUIDIZED-BED
BIOFILM REACTOR.
Montgomery (James M.) Consulting Engineers,
Inc., Pasadena, CA.
For primary bibliographic entry see Field 5D.
W90-08346

CALCULATION OF DAILY AVERAGE PHO-
TOSYNTHESIS.
Michigan Technological Univ., Houghton. Dept.
of Civil Engineering.
For primary bibliographic entry see Field 2H.
W90-08352

ANALYTICAL MODEL FOR FURROW IRRI-
GATION.
Louisiana State Univ., Baton Rouge. Dept. of Civil
Engineering.
For primary bibliographic entry see Field 3F.
W90-08354

LAND-GRADING DESIGN BY USING NON-
LINEAR PROGRAMMING.
Baghdad Univ. (Iraq). Coll. of Engineering.
For primary bibliographic entry see Field 3F.
W90-08359

ESTIMATING IRRIGATION DIVERSIONS
FOR MAJOR TEXAS RICE-GROWING AREA.
Lower Colorado River Authority, Austin, TX.
Water and Wastewater Utilities Program.
For primary bibliographic entry see Field 3F.
W90-08361

CHARACTERIZING CYCLIC WATER-LEVEL
FLUCTUATIONS IN IRRIGATION CANALS.
Yakima Indian Nation, WA.
For primary bibliographic entry see Field 3F.
W90-08362

IRRIGATION PLANNING BY MULTILEVEL
OPTIMIZATION.
Asian Inst. of Tech., Bangkok (Thailand). Div. of
Water Resources Engineering.
For primary bibliographic entry see Field 3F.
W90-08363

SHORT-TERM PRECIPITATION PATTERNS
IN CENTRAL HONSHU, JAPAN: CLASSIFICA-
TION WITH THE FUZZY C-MEANS
METHOD.
Meteorological Research Inst., Yatabe (Japan).
For primary bibliographic entry see Field 2B.
W90-08365

MEASUREMENTS OF TURBULENCE IN THE
BENTHIC BOUNDARY LAYER OVER A
GRAVEL BED.
Proudman Oceanographic Lab., Birkenhead (Eng-
land).
For primary bibliographic entry see Field 2J.
W90-08376

COMMUNITY SIMILARITY AND THE ANAL-YSIS OF MULTISPECIES ENVIRONMENTAL DATA: A UNIFIED STATISTICAL APPROACH.
Virginia Polytechnic Inst. and State Univ., Blacks-burg. Center for Environmental and Hazardous Material Studies.
E. P. Smith, K. W. Pontasch, and J. Cairns Jr.
Water Research WATRAG, Vol. 24, No. 4, p 507-514, April 1990. 1 fig, 3 tab, 31 ref, append. Dept. of Energy contract DE-AC05-84OR21400.

Descriptors: *Baseline studies, *Data interpreta-tion, *Statistical methods, *Statistical models, *Water pollution effects, Metals, Multivariate anal-ysis, New River, Permutation tests, Simulation analysis, Virginia, Zinc.

The number of species or variables in some de-signed environmental studies is too large for analy-sis using standard inferential statistics. Biological data arising from multispecies studies through the use of measures of community similarity were ana-lyzed. Of interest are three basic questions con-cerning these studies: (1) are the differences due to the locations or treatments; (2) which species are primarily involved in the differences; (3) which locations are different. To analyze the type of data, a two-stage procedure and follow-up methods were developed. First, data was reduced using a measure of similarity or distance. Then, a permuta-tion procedure was used to make inferences. As-suming the hypothesis is rejected, several follow-up analyses were presented as tools in understand-ing the causes of rejection. For example, to further understand treatment effects, a randomization based, multiple comparison procedure may be used; to better understand what differences the similarity or distance measure describes, a method based on removal of a species is given. The meth-ods are illustrated on a study of the effects of zinc on the periphyton community in the New River, VA. One drawback to the permutation approach is that the size difference may be statistically signifi-cant but not biologically important. If all between similarities are only 0.01 less than the smallest within similarity, the degree of significance using the permutation test is the same as if the difference were 0.50. This problem is shared with many non-parametric methods and similar problems occur in classical statistical methods, but should not com-monly occur. (Chonka-PTT)
W90-08395

SIMULATION OF GROUND-WATER FLOW IN THE CAMBRIAN-ORDOVICIAN AQUIFER SYSTEM IN THE CHICAGO-MILWAUKEE AREA OF THE NORTHERN MIDWEST.
Geological Survey, Madison, WI.
For primary bibliographic entry see Field 2F.
W90-08402

HIGH PLAINS REGIONAL AQUIFER--MAP-PING IRRIGATED AGRICULTURE USING LANDSAT DATA.
Geological Survey, Menlo Park, CA.
G. Thelin.
IN: Regional Aquifer Systems of the United States: Aquifers of the Midwestern Area. Papers Present-ed at 24th Annual AWRA Conference and Sympo-sium, November 6-11, 1988, Milwaukee, WI. AWRA Monograph Series No. 13, 1989. American Water Resources Association, Bethesda, Maryland. p 219-223, 4 ref.

Descriptors: *Groundwater irrigation, *High Plains Regional Aquifer, *Irrigation districts, *Mapping, *Regional Aquifer Systems Analysis, *Remote sensing, Groundwater management, Groundwater mining, Groundwater use, Irrigation practices, Landsat, Satellite technology.

Data from 94 Landsat scenes were used to map irrigated agriculture above the High Plains aquifer. Irrigated acreage estimates are one critical element in a groundwater flow model being used by the U.S. Geological Survey to determine the current trends in the amount and distribution of irrigation water. Several methods for determining irrigated acreage were evaluated. Digital analysis of Land-sat data proved to be the most suitable approach and was used in a two-phase mapping effort using

Landsat digital data from both the 1978 and 1980 growing seasons. The first phase, a test of analyti-cal procedures, used 1978 Landsat data to map the majority of the High Plains. The test employed a cluster analysis technique to derive acreage esti-mates of irrigated agriculture, dryland agriculture, and rangeland using 35 summer Landsat scenes. Based on the first-phase test results, several modifi-cations were made to improve analytical tech-niques for the second-phase operational mapping using 1980 Landsat data. The analysis of 1980 data used a ratio technique to analyze 59 spring and summer Landsat scenes. Acreage estimates of irri-gated agriculture, dryland agriculture, and range-land were aggregated to form a data base contain-ing approximately 200,000 grid cells measuring 1-minute of latitude by 1-minute of longitude. Per-centages for each cover type were calculated and then combined with sampled irrigation application rates for use in the groundwater flow model to compute estimates of irrigation water use. (See also W90-08400) (Author's abstract)
W90-08412

CLIMATIC CONDITIONS OF THE FUTURE.
Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR). Research Dept.
For primary bibliographic entry see Field 2B.
W90-08566

PROJECTED CLIMATIC CHANGES AND IM-PACTS IN EUROPE DUE TO INCREASED CO2.
Muenster Univ. (Germany, F.R.). Center for Ap-plied Climatology and Environmental Studies.
For primary bibliographic entry see Field 2B.
W90-08567

SIMULATION OF THE IMPACT OF CO2 AT-MOSPHERIC DOUBLING ON PRECIPITA-TION AND EVAPOTRANSPIRATION--STUDY OF THE SENSITIVITY TO VARIOUS HY-POTHESES.
Institut Royal Meteorologique de Belgique, Brus-sels. Hydrology Section.
For primary bibliographic entry see Field 2B.
W90-08568

LONG-TERM VARIABILITY OF PRECIPITA-TION IN AUSTRIA.
Technische Univ., Vienna (Austria). Inst. fuer Hy-draulik Gewasserkunde und Wasserwirtschaft.
For primary bibliographic entry see Field 2B.
W90-08569

LONG TERM VARIATIONS OF THE WATER BALANCE IN SWEDEN--A PRELIMINARY STUDY.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
For primary bibliographic entry see Field 2A.
W90-08570

CHANGES OF PRECIPITATION IN FINLAND.
Finnish Meteorological Inst., Helsinki.
For primary bibliographic entry see Field 2B.
W90-08571

VALIDATION OF RESIDUAL ENERGY BUDG-ETS FROM ATMOSPHERIC CIRCULATION DATA AGAINST SATELLITE MEASURE-MENTS OF THE NET RADIATION.
Helsinki Univ. (Finland). Dept. of Meteorology.
For primary bibliographic entry see Field 2A.
W90-08575

LONG TERM EVOLUTION OF THE ITALIAN CLIMATE OUTLINED BY USING THE STANDARDIZED ANOMALY INDEX (SAI).
Servizio Meterologico dell'Aeronautica, Rome (Italy).
A. Giuffrida, and M. Conte.
IN: Conference on Climate and Water. Volume I. September 11-15, Helsinki, Finland. Valtion Paina-tuskeskus, Helsinki, Finland. 1989. p 197-208, 6 fig,

2 tab, 5 ref.

Descriptors: *Climatic changes, *Climatology, *Italy, *Meteorological data, *Precipitation, Data processing, Historical trends, Standardized Anom-aly Index, Temperature.

Trends of temperature and precipitation in Italy were studied by using data sets covering approxi-mately one century. The experiment showed a positive trend for temperature and a negative trend for precipitation. The Standardized Anomaly Index (SAI), widely applied to precipitation was extended to apply to temperature. This type of index is capable of giving useful and synthetic climatic indications for large territories expressed as a single value. More complex analyses can then be carried out using this information. The SAI was applied to groups of Italian stations for which temperature data was available since 1866 and rain data since 1813. For temperature a clear and signif-icant trend was shown. The SAI values ranged from -0.30 to +0.19, that is, extending the Sharon Nicholson's subdivision from below the normal to positive normal values. For precipitation a smooth-ing of the SAI of the whole set of data showed a 'parabolic' shape indicating an increase of rainfall in the first half of the set and a decrease starting approximately since 1900. The decrease was par-ticularly marked in the last 30 years. (See also W90-08565) (Author's abstract)
W90-08579

SOIL MOISTURE DYNAMICS IN SOUTH-CENTRAL SWEDEN IN A 100 YEAR PERSPEC-TIVE.
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
For primary bibliographic entry see Field 2G.
W90-08583

HYDROLOGICAL MODELING OF HAPEX REGION USING SATELLITE OBSERVA-TIONS.
Centre de Recherches en Physique de l'Environne-ment, Issy-les-Moulineaux (France).
For primary bibliographic entry see Field 2A.
W90-08585

JOINT APPLICATION OF TREND TESTING AND HYDROLOGICAL MODELS IN DISTIN-GUISHING BETWEEN HUMAN INFLUENCES AND CLIMATIC EFFECTS ON THE HYDRO-LOGICAL CYCLE.
Geological Survey, Reston, V.A.
For primary bibliographic entry see Field 2A.
W90-08596

CLIMATE-INDUCED EFFECTS ON THE WATER BALANCE--PRELIMINARY RESULTS FROM STUDIES IN THE VARPINGE EXPERI-MENTAL RESEARCH BASIN.
Lund Univ. (Sweden). Dept. of Water Resources Engineering.
For primary bibliographic entry see Field 2A.
W90-08598

WATER BALANCE INVESTIGATIONS IN SWISS ALPINE BASINS--TOOL FOR THE IM-PROVED UNDERSTANDING OF IMPACTS OF CLIMATIC CHANGES ON WATER RE-SOURCES.
Service Hydrologique National, Bern (Switzer-land).
For primary bibliographic entry see Field 2A.
W90-08600

GRADUAL CLIMATE CHANGE AND RESULT-ING HYDROLOGIC RESPONSE.
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 2A.
W90-08601

MODELING CHANGES IN THE WATER QUALITY OF THE SAVA RIVER CAUSED BY

IMPOUNDING WATER AT THE VRHOVO HYDROELECTRIC POWER PLANT.
Ljubljana Univ. (Yugoslavia). Inst. za Zdravstveno Hidrotehniko.
For primary bibliographic entry see Field 6G.
W90-08626

RISK MANAGEMENT OF ACCIDENTAL WATER POLLUTION: AN ILLUSTRATIVE APPLICATION.
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
J. Pinter, P. Benedek, and A. Darazs.
Water Science and Technology WSTED4, Vol. 22, No. 5, p 265-274, 1990. 1 fig, 23 ref.

Descriptors: *Accidents, *Danube River, *Model studies, *Risk assessment, *Water pollution control, *Water pollution effects, Drinking water.

A general risk assessment and management approach is proposed for analyzing and controlling (accidental) environmental pollution events. An attempt is made to demonstrate that the conceptual approach of risk analysis may contribute to 'traditional' environmental management, specifically, to water pollution control. This is done by introducing a general framework for modelling environmental risks and applying it in a simplified case study. A 'technocratic' standpoint was taken when concentrating on the modelling and numerical solution aspects; therefore important economic, social, political, jurisdictional etc. details were postponed for further, site-specific investigations. The modelling concept is illustrated by a simplified case study, describing hypothetical point-source toxic pollution of the Danube River and its effect on the downstream bank-filtered well system. The numerical example indicates the viability of the suggested approach, highlighting also the necessary information base of environmental risk studies. (Agostine-PTT)
W90-08641

8. ENGINEERING WORKS

8A. Structures

CONCEPTS FOR INSTALLATION OF THE PRECAST CONCRETE STAY-IN-PLACE FORMING SYSTEM FOR LOCK WALL REHABILITATION IN AN OPERATIONAL LOCK.
Berger/Abam Engineers, Inc., Auburn, WA.
For primary bibliographic entry see Field 8F.
W90-07510

INTEGRATED SEISMIC RISK ANALYSIS FOR EARTH DAMS.
Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8E.
W90-07513

ENGINEERING HYDROLOGY TECHNIQUES IN PRACTICE.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W90-07548

SOLUTION OF THE DAM-RESERVOIR INTERACTION PROBLEM USING A COMBINATION OF FEM, BEM WITH PARTICULAR INTEGRALS, MODEL ANALYSIS AND SUBSTRUCTURING.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
C. S. Tsai, G. C. Lee, and R. L. Ketter.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-207146. Price codes: A04 in paper copy, A01 in microfiche. Technical Report NCEER-88-0036, December 31, 1988. 49p, 22 fig, 20 ref. NCEER Contract 88-3017, and NSF Master Contract ECE86-07591.

Descriptors: *Boundary element method, *Dams, *Data interpretation, *Finite element method,

*Hydraulic structures, Mathematical equations, Mathematical models, Model studies, Reservoirs, Statistical models.

This report presents a new analysis procedure, for dam-reservoir interactions. The method is a combination of the finite element method (FEM), the boundary element method (BEM) with particular integrals, modal analysis and substructuring. The difficulty of the nonsymmetric matrix generally introduced from the boundary element method with nonsymmetric and full matrix at the interface between the finite element and the boundary element methods is overcome by using the described procedure. A new boundary integral equation, which adopts a frequency-independent fundamental solution, is derived for solving the scalar wave equation. Modal analysis of the dam without the reservoir is first addressed. Then, the modal added-mass and added-loads are calculated by using the boundary element method with particular integrals to solve the Helmholtz equation along with the boundary conditions, which are functions of modal shapes and generalized coordinates. After obtaining the modal added-mass and added-loads, the dam-reservoir system can be reformed in terms of modal shapes--with the reservoir empty--to obtain the natural frequencies, modal shapes, and response of the total system. Using this procedure, not only can the number of degrees-of-freedom of the nonsymmetric, full matrix be significantly reduced, but there is no need to recalculate the properties of the dam without the reservoir when the level of the water changes. (Author's abstract)
W90-07557

DESIGN AND PERFORMANCE OF SPILLWAY CHUTE AERATORS.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
P. Rutschmann, and W. H. Hager.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 1, p 36-42, January 1990. 4 fig, 1 tab, 13 ref, append.

Descriptors: *Air entrainment, *Hydraulic design, *Hydraulic models, *Hydroelectric plants, *Spillways, Cavitation, Hydraulic engineering, Hydraulic structures, Mathematical analysis, Model studies, Overflow channels.

Aeration of high velocity spillway chute flows by aerators is widely used to avoid cavitational erosion. The present aerator design is restricted to specific aerator geometries. A study was conducted with the aim of developing a design procedure for spillway chute aerators. Model and prototype tests were conducted with a wide parameter variation concerning the geometry, subpressure conditions below the nappe, and the approaching flow. The project included measurements collected at three different chutes, one of which was a small prototype chute. Three different ramp angles, combined with three different step heights, were tested. Observations included the effects of the approaching flow, the subpressure below the nappe, the jet length, the pressure conditions in the region of the jet impact point, and dynamic bottom pressure fluctuations on the aerator. Both theory and experiment demonstrate that the air entrainment is a shear dominated phenomenon. (Tappert-PTT)
W90-07612

DETERMINING OPTIMUM SPILLWAY CAPACITY BASED ON ESTIMATED FLOOD DISTRIBUTION.
California Univ., Davis. Dept. of Land, Air and Water Resources.
A. Afshar, and M. A. Marino.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 1, p 44-53, January 1990. 5 fig, 6 tab, 9 ref. Agricultural Research Service Cooperative Agreement 4116-H.

Descriptors: *Design floods, *Hydraulic design, *Hydraulic engineering, *Hydroelectric plants, *Overflow channels, *Risk assessment, *Spillways, Design standards, Mathematical analysis, Model studies.

The safety of an embankment dam depends upon the sufficiency of its spillway capacity. The spillway design flood (SDF) is a function of social, moral, and economic, as well as technological judgement. In cases where clearly defined criteria or methodologies do not exist, selection of the SDF may prove to be difficult and controversial. Traditional methods of design flood estimation attempt to balance risk and economic benefit. The SDF is characterized by the design return period or by an annual exceedance probability. Once the design discharge is determined, the capacity of a spillway can be selected for a specific safety factor. The return period design methods do not systematically take into account the many uncertainties involved with spillway design. To establish a set of design criteria for selecting the SDF, an optimum risk analysis was performed. A semi-analytical solution to the risk-based design model was generated, as well as a sensitivity analysis of the results to changes in the values of input parameters. Model input included spillway installation cost for different reliability levels, possible damage to the structure and downstream properties, potential benefits lost as a result of system failure, and the hydrological parameters of the watershed. Application of the optimum risk-based method showed that the optimum risk not only varies from one project to another but also within a given site, depending upon the interest rate, service life of the structure, downstream conditions, and the design characteristics of the dam and the spillway. (Tappert-PTT)
W90-07613

ANALYSIS OF SPIRAL VORTEX AND VERTICAL SLOT VORTEX DROP SHAFTS.
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-07827

HEAD LOSSES AT JUNCTION BOXES.
James Cook Univ. of North Queensland, Townsville (Australia).
For primary bibliographic entry see Field 8B.
W90-07828

DIVIDING FLOW IN OPEN CHANNELS.
Concordia Univ., Sir George Williams Campus, Montreal (Quebec).
For primary bibliographic entry see Field 8B.
W90-07837

FILTER FABRIC CONTROLS QUICKSAND DURING SEWER CONSTRUCTION.
For primary bibliographic entry see Field 5D.
W90-07945

RETHINKING FLOOD-CONTROL CHANNEL DESIGN.
Williams (Philip) and Associates, San Francisco, CA.
For primary bibliographic entry see Field 4A.
W90-07960

LINING UP AGAINST OIL.
Smith-Emery Co., Los Angeles, CA.
P. Constantine.
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 1, p 70-71, January 1990.

Descriptors: *Conveyance structures, *Oil pollution, *Pipelines, *Pipes, *Tunnel linings, *Water conveyance, Seepage control, Tunnel construction.

When the Newhall Tunnel section of Southern California's Metropolitan Water District distribution system experienced oil seepage from the surrounding oil-bearing geologic formation, the water district decided to line the tunnel with a 1/2 inch thick steel liner. Oil was being pulled into the tunnel by a capillary type of attraction, causing problems in the treatment plant. After dewatering the tunnel, a survey crew towed a specially-made trailor through the length of the problem area

(3,000-ft section) to determine what size piping would fit in the tunnel. The liner was constructed in 20 ft sections each with an inside diameter of 19 ft-8 in. Temporary guide plates were welded to each section to assure easy alignment of pipe sections. After the pipes were welded together, the interior was sandblasted and a coating of high-solids epoxy was applied. Grouting was accomplished by special conveyance trucks. Quality control was coordinated between supervisors from the Metropolitan Water District and inspectors from Smith Emery, Los Angeles. Welding quality control required continuous visual inspection and nondestructive testing by dye penetrant method. Grouting inspection involved sampling for compressive strength and slump tests at intermediate points from the surface to the final pump. The total cost for the liner and its installation was $8.3 million. The liner has so far kept the water entering the plant free of oil. (Geiger-PTT)
W90-07962

PITTING CORROSION BEHAVIOUR OF ALUMINIUM IN WATER DESALINATION PLANTS.
National Research Centre, Cairo (Egypt). Dept. of Electrochemistry.
For primary bibliographic entry see Field 3A.
W90-07970

GEOTEXTILES CONSTRUCTION CRITERIA.
Soil and Material Engineers, Inc., Cary, NC.
For primary bibliographic entry see Field 8G.
W90-08133

SEEPAGE, DRAINAGE, AND FLOW NETS.
For primary bibliographic entry see Field 8B.
W90-08154

RELIABILITY-CONSTRAINED PIPE NETWORK MODEL.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W90-08210

RISK-COST DESIGN OF PAVEMENT DRAINAGE SYSTEMS.
GKY and Associates, Inc., Springfield, VA.
For primary bibliographic entry see Field 4C.
W90-08275

OPTIMAL HYDROPOWER SYSTEM CONFIGURATION BASED ON OPERATIONAL ANALYSIS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
G. N. Paudyal, D. L. Shrestha, and J. J. Bogardi.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 2, p 233-246, March/April 1990. 4 fig, 2 tab, 10 ref.

Descriptors: *Dam design, *Hydroelectric power, *Nepal, *Reservoirs, Energy, Operating policies, Stochastic models.

The problem of optimal multiunit hydropower system configuration was analyzed considering long-term operational aspects. The spatial distribution of individual system elements such as reservoirs and the vertical configurations representing heights of various dams, full supply levels and minimum operating levels of the reservoirs were selected for optimum energy generation potential. The objective of maximizing the monthly firm energy was successfully achieved first by applying the Incremental Dynamic Programming (IDP) technique, and then by the Stochastic Dynamic Programming (SDP) method which incorporates the streamflow stochasticity into the system. SDP maximized the expected total annual energy generation subject to a prespecified monthly firm power output. Transitional probabilities were derived from the available historical streamflow records. The results obtained could be used in planning a reservoir system and in deriving a long-term operational policy. In this study, they were

used in deciding the optimum system configuration in a river basin development problem in Nepal. (Author's abstract)
W90-08277

DESIGN OF CHINA'S MING TOMBS PUMPED-STORAGE SCHEME.
Ministry of Water Resources and Electric Power, Beijing (China). Information Research Inst.
X. Sizheng, and Z. Jinshen.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 4, p 18-23, April 1990. 2 fig, 2 tab.

Descriptors: *China, *Civil engineering, *Hydroelectric plants, *Pumped storage, *Water supply development, Concrete construction, Construction methods, Cost repayment, Electrical equipment, Feasibility studies, Reservoirs, Waterways.

Following a feasibiliy study completed in September 1988, the Ming Tombs pumped storage project has been identified as technically and economically feasible. This 800 MW installation will be the second largest pumped storage station in mainland China (after the 1200 MW Guangzhou project in South China, now under construction). The general layout includes two reservoirs, a dual waterway system, an underground powerhouse complex, a power intake and tailrace outlet structure. Reservoir seepage has been corrected with a concrete cutoff wall. It has been determined that a supplementary water supply is needed to maintain the necessary water level conditions for the normal operation of the pumped storage project, and will be obtained from an interbasin water transfer scheme. Four main three-phase transformers will be installed, with a computerized control system and composite fiber optic overhead ground wire telecommunications systems. The main construction volumes for the project will be as follows: open excavation: 5,360,000 cu m; underground excavation: 590,000 cu m; and, concrete and shotcrete: 309,500 cu m. The workforce at the peak of construction is likely to comprise about 6900 people. The annual peak power production of the Ming Tombs project is planned to be 1.2 TWh, and the scheme is estimated to have a payback period of 15 years. (Fish-PTT)
W90-08336

ENGINEERING MEASURES: WATERWAYS AND DIVERSION CHANNELS.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 3F.
W90-08537

8B. Hydraulics

DESIGN AND PERFORMANCE OF SPILLWAY CHUTE AERATORS.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
For primary bibliographic entry see Field 8A.
W90-07612

DETERMINING OPTIMUM SPILLWAY CAPACITY BASED ON ESTIMATED FLOOD DISTRIBUTION.
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 8A.
W90-07613

ANALYSIS OF SPIRAL VORTEX AND VERTICAL SLOT VORTEX DROP SHAFTS.
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
M. C. Quick.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 309-325, March 1990. 8 fig, 8 ref, 2 append.

Descriptors: *Flow control, *Flow discharge, *Hydraulic design, *Hydraulic structures, *Mathematical models, Energy dissipation, Hydraulics.

Discharging water safely through large vertical distances requires careful design for energy dissipation and flow control. Vortex drop structures have proved to be a flexible and reliable method for achieving this safe control and energy dissipation. Two designs of vortex drop structures are developed in this paper, both of which are based on a theory shown to give a good prediction of head-discharge relationships. The first design is the widely used spiral guide wall design, in which control is shared between the critical section at the top of the shaft and the vortex inducing assymetry of the guide wall inlet design. A second simplified and more space saving design, called the vertical slot vortex drop structure, is also analyzed, in which, although the flow conditions and analysis are quite different, the resulting head-discharge relationship is quite similar to the spiral guide wall design. For both designs, the head-discharge relationship is shown to be almost linear and the theoretical and measured discharges are in close agreement. The proposed vertical slot design produces a stable air core, similar to the spiral guide wall design, and consequently the flow is free from risk of surging to the pipe-full flow condition. The compactness of the new design is especially suitable for underground installations. (Author's abstract)
W90-07827

HEAD LOSSES AT JUNCTION BOXES.
James Cook Univ. of North Queensland, Townsville (Australia).
A. J. Johnston, and R. E. Volker.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 326-341, March 1990. 5 fig, 5 tab, 13 ref, 2 append.

Descriptors: *Head loss, *Hydraulic design, *Hydraulics, *Mathematical models, *Pipe flow, *Storm drains, Hydraulic structures, Pipes.

When designing efficient stormwater drainage systems, it is customary to make allowances for the energy losses developed in components of the systems. The explanation of the hydraulics of junctions boxes is poor in comparison with the corresponding explanation of the hydraulics of pipes. The results of a detailed experimental hydraulic model study of the hydraulic interaction in two common junction box configurations are presented. For a three-pipe configuration a recently proposed empirically based model is shown to adequately represent both the lateral and longitudinal loss coefficients in a variety of flow conditions. The results from this configuration also indicate that substantial reductions in head losses at the box are possible through the incorporation of strategically placed deflector plates in the base of the junction box. The two-pipe configuration results indicate that the benching of the box floor leads to the improved hydraulic efficiency of the box. Circulating mechanisms in the boxes are shown to be strongly related to corresponding head losses at the boxes. Both configurations demonstrate that the influences of Froude number and box submergence are not major, but nevertheless are important in some flow conditions. (Author's abstract)
W90-07828

GATE VIBRATIONS DUE TO UNSTABLE FLOW SEPARATION.
Worcester Polytechnic Inst., Holden, MA. Alden Research Labs.
For primary bibliographic entry see Field 8C.
W90-07829

INTERFACIAL MIXING DRIVEN BY MEAN SHEAR AND OSCILLATING GRID.
State Univ. of New York at Buffalo. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W90-07832

OBSERVATIONS OF OUTFLOWING JETS.
Ecole Polytechnique Federale de Lausanne (Switzerland). Dept. de Genie Civil.
W. H. Hager.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 441-448, March 1990. 4 fig, 8 ref, append.

Descriptors: *Cross-sections, *Hydraulics, *Mathematical models, *Model studies, *Orifice flow, Flow models, Flow pattern, Froude number, Gravity, Surface tension, Viscosity.

Although outflowing jets from vertical orifices have been studied some centuries ago, there seems to be a recent interest in such phenomena. The description of the jet geometry is complicated by the simultaneous effects of gravity, surface tension, and viscosity. Appropriate numerical modeling must account for the spatial flow features; a simplified approach might be based on an irrotational flow model. This study aims at presenting the alternative features of outflowing thin jets from rectangular orifices from an analysis of photographs. The main flow patterns are described mathematically and the differences between the jets with horizontal and vertical main axes are outlined. (Author's abstract)
W90-07836

DIVIDING FLOW IN OPEN CHANNELS.
Concordia Univ., Sir George Williams Campus, Montreal (Quebec).
A. S. Ramamurthy, T. M. Duc, and L. B. Carballada.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 449-455, March 1990. 1 fig, 2 tab, 8 ref.

Descriptors: *Channel flow, *Flow channels, *Flow equations, *Mathematical models, *Model studies, *Open-channel flow, Control gates, Froude number, Junctions.

Junctions are of considerable importance in the study of open channel flows. For dividing flow at right-angled junctions of rectangular open channels, an estimate of the discharge ratio was obtained in terms of the Froude numbers in the main channel upstream and downstream of the junction. Experimental data is provided to validate the proposed model which accommodates control gates and does not require the measurement of flow depths in the branch channel. The model has much wider applications than previous models, since there are no restrictions to the nature of flow in the branch channel. (Author's abstract)
W90-07837

CHANNEL EVOLUTION OF THE HATCHIE RIVER NEAR THE U.S. HIGHWAY 51 CROSSING IN LAUDERDALE AND TIPTON COUNTIES, WEST TENNESSEE.
Geological Survey, Nashville, TN. Water Resources Div.
For primary bibliographic entry see Field 2J.
W90-07840

RETHINKING FLOOD-CONTROL CHANNEL DESIGN.
Williams (Philip) and Associates, San Francisco, CA.
For primary bibliographic entry see Field 4A.
W90-07960

HYDRAULIC PROPERTIES OF GEOTEXTILES.
Tensar Corp., Morrow, GA.
For primary bibliographic entry see Field 8G.
W90-08127

SEEPAGE, DRAINAGE, AND FLOW NETS.
H. R. Cedergren.
John Wiley and Sons, New York, New York. 1989. 465p.

Descriptors: *Drainage, *Flow nets, *Hydraulic structures, *Seepage, Earth dams, Flow profiles, Hydraulic engineering, Levees, Permeability, Slopes, Stabilization, Surface drainage.

In the past, when designers relied on 'intuition' and 'rules-of-thumb' for decisions about the design of overflow weirs, earth dams, pavements, and other facilities exposed to the detrimental actions of water, failures and inefficiencies were all too common. With the development of the 'rational' and 'experimental' methods, designers began to have a better understanding of the true nature of soil masses and earth foundations and how to design safe, economical engineering facilities. But, the flow of water in natural formations and in drainage materials intended to control it has somehow remained a mystery to many. This book presents simple methods for analyzing the discharge needs of drains for all kinds of civil engineering works needing protection from water, and many illustrations of the practical application of these principles. Part I contains chapters on permeability, seepage fundamentals, and flow net construction. Chapter 4 on flow nets provides instructions and step-by-step examples that should help beginners and advanced students alike to develop skill in flow-net construction. Practical ways to obtain realistic large-scale evaluations of permeability from spreading or receding groundwater mounds are presented in Chapter 2; a practical method for correcting for semiturbulent-to-turbulent flow in coarse gravels and open-graded drainage layers is given in Chapter 3. Chapter 5 on filter and drain design describes basic design concepts and emphasizes the great advantages of composite drains for the control of seepage in many kinds of civil engineering works. Other chapters in Part II present typical seepage analyses and drainage designs for earth dams and levees (Chapter 6), foundation dewatering and stabilization by drainage (Chapter 7), slope improvement by drainage (Chapter 8), drainage of roads, airfields, and other surface facilities (Chapter 9), the improvement of miscellaneous structures by drainage (Chapter 10), and the protection of groundwaters from contamination (Chapter 11). (Lantz-PTT)
W90-08154

HYDRAULIC TRANSIENTS IN ROCK-BORED TUNNELS.
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.
L. Suo, and E. B. Wylie.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 2, p 196-210, February 1990. 11 fig, 1 tab, 16 ref. NSF Grant No. MSM-8709564.

Descriptors: *Hydraulic transients, *Rock properties, *Tunnel hydraulics, *Tunnels, Dispersion, Frequency analysis, Pipelines, Resonance, Wave propagation, Wave velocity.

The nature of hydraulic transients in rock-bored tunnels is expected to be frequency-dependent. A complex-valued and frequency-dependent wave speed in a rock-bored tunnel filled with water was formulated with consideration of the dynamic effect of the rock mass surrounding the tunnel, and its physical meaning was defined. The theory of hydraulic resonance in pipelines was extended to tunnels with frequency-dependent wave speeds. Results show significant changes in resonant conditions, illustrate dramatic reductions in response at practical frequencies, and confirm the low probability of the occurrence of high-frequency resonances in long tunnels. A variation in the impulse response method was applied for transient analysis. It was found that pressure waves propagating in tunnels are subject to dispersion and attenuation, and the complex wave speed may alter a transient to some extent, depending on the frequency spectrum of the transient. (Author's abstract)
W90-08209

ACCOUNTING FOR DENSITY FRONT ENERGY LOSSES.
Contra Costa Water District, Concord, CA.
For primary bibliographic entry see Field 2E.
W90-08213

INVESTIGATION OF TURBULENT FLOW OVER DUNES.
Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
For primary bibliographic entry see Field 2E.

W90-08251

LINEAR HYPERBOLIC MODEL FOR ALLUVIAL CHANNELS.
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W90-08252

MECHANICS OF LOCAL SCOUR AROUND SUBMARINE PIPELINES.
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
Y. M. Chiew.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 515-529, April 1990. 9 fig, 2 tab, 11 ref, append.

Descriptors: *Eddies, *Erosion, *Flow around objects, *Hydraulic models, *Model studies, *Pipelines, *Scour, Bottom currents, Hydraulic gradient, Sediment erosion, Underwater.

Interaction between a submarine pipeline and an erodible bed has attracted much attention because of its importance in offshore engineering. A study was conducted to improve understanding of the mechanism causing scour in unidirectional current. Experiments have shown how local scour develops around submarine pipelines in noncohesive sediments. The study shows that piping is the dominant cause of the initiation of scour. Piping and the stagnation eddy combine to undermine the pipeline, and mark the onset of scour. The critical hydraulic gradient associated with the initiation of scour is equal to the flotation gradient of the bed sediment. The pressure drop between the stagnation pressure upstream and wake pressure downstream of the pipe induces this hydraulic gradient. When a pipe is just embedded, the onset of scour does not occur if the ratio of the flow depth to pipe diameter exceeds 3.5. Similarly, the onset of scour does not occur for half-buried pipes. The reduction in pressure gradient across the pipeline for these flow/pipe combinations accounts for the lack of scour. The onset of scour can be prevented by placing an impermeable membrane underneath the pipeline. (Author's abstract)
W90-08254

ROUGHNESS EFFECTS ON FLOW AND SHEAR STRESS NEAR OUTSIDE BANK OF CURVED CHANNEL.
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
Y. C. Jin, P. M. Steffler, and F. E. Hicks.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 563-577, April 1990. 11 fig, 2 tab, 7 ref, append.

Descriptors: *Bank protection, *Channel erosion, *Channel flow, *Flow characteristics, *Hydraulic roughness, *Scour, Channel morphology, Riprap, Shear stress, Turbulent flow, Velocity distribution.

Curved channel flow characteristics have a great effect on erosion and sediment transport in rivers, and are particularly important in the design of river engineering and bank stabilization works. Rational bank protection design requires significantly more detailed information on the complex flow field in the vicinity of the bank and especially the outside bank where rapid variations occur. Velocity and turbulence distributions were measured in a 270 degree curved open channel of half trapezoidal section with extra roughness applied to the outside bank slope. The purpose of the investigation was to provide some understanding of flow mechanics that may be useful in the design of riprap protection. Profile-averaged velocity and bed shear velocity distributions were calculated. A significant variation of bed shear up the slope and a much higher stress near the toe of the slope were found for the roughened outside bank slope. It was found that a reasonable correlation of the velocity and bed shear stress on the bank is given by a form of the Colebrook equation. Lateral momentum transfer by secondary flow and turbulent stress were

also found to be significant in the bank vicinity. (Author's abstract)
W90-08257

SKIMMING FLOW IN STEPPED SPILLWAYS.
Alberta Univ., Edmonton. Dept. of Civil Engineering.
N. Rajaratnam.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 4, p 587-591, April 1990. 1 fig, 6 ref.

Descriptors: *Energy dissipation, *Flow equations, *Overflow channels, *Spillways, Flow characteristics, Friction, Mathematical analysis, Shear stress.

In a stepped spillway, the spillway face is provided with a series of steps, from near the crest to the toe. Flow over stepped spillways can be divided into nappe flow and skimming flow regimes. In the skimming flow regime, the water flows down the stepped face as a coherent stream, skimming over the steps and cushioned by the recirculating fluid trapped between them. Energy dissipation in the flow appears to be enhanced by the momentum transfer to the recirculating fluid. A method of predicting the shear stress, thus frictional energy loss of the skimming flow has been developed. For a stepped spillway of constant slope, with a large number of identical steps, the flow is assumed to become fully developed after the first few steps. Equations developed were evaluated using previously published experimental observations obtained on a scale model of a dam spillway. An estimate of the energy loss for skimming flow in a stepped spill is presented. For a stepped spillway with a slope of 1 vertical on 0.78 horizontal, the fluid friction coefficient was evaluated using the experimental results from the model spillway and found to be about 0.18. (VerNooy-PTT)
W90-08259

COMPUTING PHASE SPEEDS AT OPEN BOUNDARY.
Institute for Naval Oceanography, Stennis Space Center, MS.
For primary bibliographic entry see Field 2L.
W90-08260

MODEL TESTS OF THE URFA TUNNEL SYSTEM IN TURKEY.
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
M. Bayazit, and I. Avci.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 4, p 39-44, April 1990. 9 fig, 1 tab, 7 ref.

Descriptors: *Hydraulic models, *Hydrodynamics, *Model testing, *Radial gates, *Tunnel construction, *Turkey, Friction loss, Head loss, Outlets, Piezometry, Pressure head, Vibrations.

Model tests have been conducted to determine the rating curves and to analyze the dynamic behavior of the regulating gates of the Urfa tunnel system in Turkey. The tunnels, now under construction, will be the longest irrigation tunnels in the world, and the radial gates at the outlet will be exposed to a wide range of pressures. The vibration of the gates was investigated first on a rigid model and then on an oscillatory model. A 1:25 scale model of the outlet structure was constructed in a laboratory. Two sets of experiments were performed for the determination of the rating curve. In the first set, only one of the tunnels was in operation, and in the second, both tunnels were operating together, gate openings being equal. Head loss in the tunnel upstream of the bifurcation was computed, taking into account friction loss and various minor losses, and added to the piezometric head measured at the entrance of the bifurcation to obtain the reservoir water level for that combination of gate opening and discharge. The ratings curves obtained for one-tunnel and two-tunnel operation show that the target discharge is easily achieved. To prevent the occurrence of undesirable negative pressures it is recommended not to open the gates more than 50 percent when only one tunnel is operated. Gate vibration tests determined dominant frequencies,

and showed that the displacements measured in the oscillatory model did not reproduce exactly those in the prototype, since the model was distorted with respect to damping and stiffness. However, the model results were on the safe side since the model gate had insufficient damping and stiffness. (Fish-PTT)
W90-08338

AERATION AT OHIO RIVER BASIN NAVIGATION DAMS.
Oak Ridge National Lab., TN. Environmental Sciences Div.
S. F. Railsback, J. M. Bownds, M. J. Sale, M. M. Stevens, and G. H. Taylor.
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 2, p 361-375, March/April 1990. 4 tab, 13 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: *Aeration, *Allegheny River, *Dam effects, *Dissolved oxygen, *Environmental engineering, *Monongahela River, *Muskingum River, *Navigation canals, *Ohio River, Flow rates, Least squares method, Model studies, Parametric hydrology, River basins, Statistical methods, Supersaturation, Water temperature.

Navigation dams can be important sources of dissolved oxygen (DO) in rivers that serve as barge-navigation canals. Aeration was measured and modeled at 28 navigation dams in the upper Ohio River basin. DO deficits upstream and downstream of the dams, water temperatures, and flow rates were measured under a variety of low-flow, high-temperature conditions. The DO deficit downstream of each dam was modeled as a linear function of the other variables. The DO deficit upstream was found to be a consistently significant predictor of DO deficits downstream of a dam. Inclusion of temperature and flow rate generally did not significantly improve the statistical aeration models. The field data show that supersaturation can occur at some dams; this means that the reaeration ratio, used by many aeration models, including Gameson's equation, cannot be assumed to model dam aeration accurately. The predictive abilities of the linear models and Gameson's were compared. The linear models reproduced historic aeration measurements as accurately as Gameson's equation did when a least squares parameter estimation method was used to parameterize Gameson's equation. For dams where supersaturation occurs, Gameson's equation did not predict aeration as accurately as the linear model. (Author's abstract)
W90-08349

HYDRAULIC DESIGN OF WINTER LAKE AERATION SYSTEM.
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 5G.
W90-08350

DESIGN OF HYDRAULIC JUMP CHAMBERS.
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
S. F. Korom, S. Sarikelle, and A. L. Simon.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 2, p 143-153, March/April 1990. 9 fig, 11 ref.

Descriptors: *Drainage engineering, *Energy dissipation, *Hydraulic design, *Hydraulic jump, *Irrigation engineering, *Open-channel flow, *Outlet channels, Concrete construction, Cost analysis, Flow velocity, Model studies.

Structures used in drainage and irrigation works all have outlet conduits, where water flow exits with a high velocity. High velocities are often reduced by rather elaborate terminal structures which require a considerable amount of concrete framework. A model study of an energy dissipator, called a hydraulic jump chamber, was performed. This structure uses precast concrete blocks secured to their inside periphery. The results showed that three sets of blocks were required for the proposed design to function. Compared with other terminal structures that use hydraulic jumps to achieve ve-

locity reductions, the hydraulic jump chamber has a simpler design, which may lead to lower costs. Hydraulic specifications and design procedures are given that minimize material and labor costs. The diameter of this design is given by equations fitted to experimental data generated by model studies. These equations are functions of the depth and Froude number of the flow entering the chamber. Most other hydraulic design variables are related to the chamber's diameter by dimensionless parameters, such as the spacing of concrete blocks, their dimensions, and their position with regard to the inlet and outlet of the chamber. (Author's abstract)
W90-08353

SIMPLE AND ACCURATE FRICTION LOSS EQUATION FOR PLASTIC PIPE.
Tennessee Univ., Knoxville. Dept. of Agricultural Engineering.
R. D. von Bernuth.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 116, No. 2, p 294-298, March/April 1990. 1 tab, 6 ref.

Descriptors: *Darcy-Weisbach equation, *Friction loss, *Hydraulic engineering, *Irrigation engineering, *Pipe flow, Flow friction, Flow rates, Irrigation design, Pipes, Reynolds number, Viscosity.

Some simple methods of calculating pipe friction loss have been found, but the more complex Darcy-Weisbach (D-W) equation is the most universally accepted. It is the calculation of the friction factor that complicates the D-W equation. Blasius proposed a simple equation for estimating the friction loss factor for very smooth pipes. The insertion of the Blasius friction factor into the D-W equation results in a combined equation with the following advantages: (1) it is theoretically sound and dimensionally homogeneous; (2) it is very accurate for plastic pipe when Reynolds numbers are less than 100,000, which is nonrestrictive for irrigation-system design using pipes smaller than 80 mm; (3) it is conveniently written in readily available terms: flow rate, length, and diameter; and (4) it can be easily corrected for viscosity changes directly or by referring to the included table of correction factors. (Fish-PTT)
W90-08364

HUMMOCKY CROSS-STRATIFICATION AND POST-VORTEX RIPPLES: LENGTH SCALES AND HYDRAULIC ANALYSIS.
University of Southern California, Los Angeles. Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-08378

ENGINEERING MEASURES FOR SOIL AND WATER CONSERVATION TERRACING AND BENCHING.
Finkel and Finkel, Yoqneam (Israel).
For primary bibliographic entry see Field 4D.
W90-08538

DEFINITE PROJECT REPORT WITH ENVIRONMENTAL ASSESSMENT FOR SECTION 14, EMERGENCY STREAMBANK PROTECTION, DES MOINES RIVER, COUNTY ROAD J-12, WAPELLO COUNTY, IOWA.
National Research Council, Washington, DC. Committee on Data Needs.
For primary bibliographic entry see Field 4D.
W90-08558

8C. Hydraulic Machinery

ELECTRONIC SPEED GOVERNING SYSTEM FOR THE PIERRE EYBESSE PLANT.
Electricite de France, Paris. Service de la Production Hydraulique.
J. M. Maujean, J. Jouve, and J. M. Ferme.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 1, p 8-11, January 1990. 3 fig.

Descriptors: *Automation, *Hydroelectric plants, *Turbines, Computers, France, Hydraulic machinery.

The technology of speed governors for hydro units has developed considerably in recent years. Advances in electronics has allowed the cost of modern speed governors to correspond to market requirements for small and medium-sized turbines. The Pierre Eybesse hydro plant, near Grenoble, France, is a small power plant with four Francis units that generate 13.5 megawatts. To reduce the operating costs of such a small plant, the operators have made efforts to fully automate the plant. Electronic speed governing units have been installed on two units of the plant. The first generation of digital programmable components were developed in the mid-1970s. Due to the development of fast microprocessors, speed governing systems are now practical over a large operating range, extending from the most simple basic functions to elaborate monitoring and communication functions. Their fundamental features are now based upon powerful electronic technology that allows the cost to correspond to market requirements for small turbines, and their development has succeeded in promoting the co-existence of both small and large units in the same network. (Tappert-PTT)
W90-07608

ASSESSING THE CONDITION OF STATOR INSULATION.
Ateliers de Constructions Electriques de Charleroi (Belgium).
J. J. Dacier.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 1, p 12-14, January 1990. 6 ref.

Descriptors: *Hydroelectric plants, *Insulation, Electrical equipment, Generators, Hydraulic machinery, Maintenance, Turbines.

One of the major factors affecting the overall reliability of a hydropower station is the reliability of its generators in general, and their stator windings in particular. Four factors exacerbate the reliability problem: only a very small defect in the whole complex leads to shutdown or failure; the cost of higher safety factors is prohibitive; providing adequate redundancy is expensive; and repairs are difficult and time-consuming. Two techniques have recently been developed to give a more accurate diagnosis of insulation than has been possible with traditional testing methods. Both techniques have the four characteristics desirable for an ideal method, including sensitivity, reliability, non-destructiveness, and the ability to detect localized weaknesses. The Testacec method determines the localized electrical condition of of the stator insulation of a rotating machine based upon the existence of partial discharges, and is effective on machines with a rated voltage larger than 3kV. The Itracec method relies on the mechanisms that cause slow polarization under an applied current to provide broad information about the insulation as a whole. Both of these methods are used by electric utility companies in Belgium for insulation diagnosis during maintenance stops of large generators. (Tappert-PTT)
W90-07609

AUTOMATIC CONTROL SYSTEM INSTALLED AT LA RANCE.
EDF Usine de La Rance, 35780 La Richardais, France.
M. Mourier, C. Digue, J. Lecouturier, and H. Piat.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 1, p 24-28, January 1990. 2 fig.

Descriptors: *Automation, *Computer programs, *Computers, *Hydroelectric plants, *Tidal powerplants, Hydraulic machinery, Operating policies.

After 22 years of operation, the control system at the La Rance tidal powerplant in Brittany, France, has been replaced. The new system will provide for more reliable performance and a more sensitive response to external conditions. Examples of auto-

mated functions include: startup and shutdown at a defined hour or water level; aided startup; load carry-over in the event of a trip-out; more efficient micro-recovery (servo-control system reducing difference between real and forecast basin level); servo control of reactive power; numerous displays; and use of a data base. A decentralized system was selected in view of the size of the plant and the cost of the wiring. Common processing and major computing functions are carried out on a central computer called the Plant Control Unit, which is connected to the automatic controllers through serial links. Peripherals such as printers, work stations, and graphic control consoles are distributed throughout the plant. (Tappert-PTT)
W90-07611

GATE VIBRATIONS DUE TO UNSTABLE FLOW SEPARATION.
Worcester Polytechnic Inst., Holden, MA. Alden Research Labs.
N. D. Thang.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 3, p 342-361, March 1990. 13 fig, 20 ref, 2 append.

Descriptors: *Flow separation, *Gates, *Hydraulic design, *Hydraulic gates, *Mathematical models, *Vibrations, Flow discharge, Hydraulics, Shear.

Vibration problems occasionally arise at hydraulic gates and have been the subject of many investigations. One of the most frequent sources of gate vibration is due to a condition of unstable flow separation and reattachment at the gate cross section. The unsteady load and vibration behavior of vertical-lift gates was investigated for different gate-bottom geometries and discharge conditions in an open channel and at a conduit inlet. In all cases, vibrations occurred in specific ranges of a dimensionless velocity parameter whenever the flow fluctuated between complete separation and reattachment at the gate bottom. The excitation mechanism was attributed to the combined effect of shear-layer instabilities and motion-induced vortices shed at the leading edge of the gate bottom. Many puzzling features of in-flow and cross-flow vibration of gates with flow underneath can thus be clarified. In addition, it is shown that the slope of the mean lift curve acting on the gate bottom provides an effective means of predicting with reasonable accuracy the critical range of gate openings with respect to potential gate vibration. (Author's abstract)
W90-07829

USE OF THE ROPE-WASHER PUMP IN MICRO-SCALE IRRIGATION.
Loughborough Univ. of Technology (England).
For primary bibliographic entry see Field 3F.
W90-07898

HYDROELECTRIC POTENTIAL IN SOUTHERN AFRICA.
For primary bibliographic entry see Field 6D.
W90-07900

WATER DISTRIBUTION SYSTEMS: A TROUBLESHOOTING MANUAL.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W90-08159

SCREENING EQUIPMENT HANDBOOK: FOR INDUSTRIAL AND MUNICIPAL WATER AND WASTEWATER TREATMENT.
For primary bibliographic entry see Field 5D.
W90-08175

RELIABILITY ANALYSIS OF PUMPING SYSTEMS.
Chinese Academy of Environmental Sciences, Beijing.
N. Duan, and L. W. Mays.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 2, p 230-248, February

1990. 4 fig, 8 tab, 13 ref. National Science Foundation Grant No. ECE-8511399.

Descriptors: *Economic efficiency, *Model studies, *Pumping plants, *Water conveyance, *Water distribution, Frequency analysis, Hydraulic design, Markov process, Mechanical failure, Probabilistic process, Water demand, Water-carrying capacity.

A new methodology has been developed for the reliability analysis of pumping stations for water-supply systems. The methodology considers both mechanical failure and hydraulic failure and models the available capacity of a pumping station as a continuous-time Markov process, using bivariate analysis and conditional probability approaches in a frequency and duration analysis framework. A supply model, a demand model, and a margin model were developed and used to compute the expected duration of a failure, expected unserved demand due to a failure, expected number of failures in the period of study, and expected total unserved demand in the period of study. Five example applications illustrate the new methodology. This methodology can be used to analyze existing pumping systems and to design new systems. (Author's abstract)
W90-08211

OPTIMAL RELIABILITY-BASED DESIGN OF PUMPING AND DISTRIBUTION SYSTEMS.
Chinese Academy of Environmental Sciences, Beijing.
N. Duan, L. W. Mays, and K. E. Lansey.
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 2, p 249-268, February 1990. 4 fig, 7 tab, 10 ref. National Science Foundation Grant No. ECE-8511399.

Descriptors: *Conveyance structures, *Model studies, *Network design, *Pumping plants, *Water conveyance, *Water distribution, Algorithms, Hydraulic models, Mechanical failure, Nonlinear programming, Optimization, Pumps.

A reliability-based optimization model for water distribution systems has been developed. The model is aimed at the following goals: (1) design of the pipe network including the number, location, and size of pumps and tanks; (2) design of the pumping system using a reliability-based procedure considering both hydraulic failures of the entire network and mechanical failure of the pumping system; and (3) determination of the optimal operation of the pumps. The optimization problem is a large mixed-integer, nonlinear programming problem that is solved using a heuristic algorithm consisting of a master problem and a subproblem. The master problem is a pure 0-1 integer programming model, and the subproblem is a large nonlinear programming model solved in an optimal control framework. The conservation of flow and energy constraints are solved implicitly for each iteration of the nonlinear optimization procedure using a hydraulic simulation model, and the reliability constraints are also solved implicitly using a reliability model. The nonlinear programming problem is solved using a generalized reduced gradient code. (Author's abstract)
W90-08212

OPTIMAL HYDROPOWER SYSTEM CONFIGURATION BASED ON OPERATIONAL ANALYSIS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 8A.
W90-08277

ANALYSIS OF SMALL HYDRO TURBINE DESIGN.
Ljubljana Univ. (Yugoslavia). Faculty of Mechanical Engineering.
F. Schweiger, and J. Gregori.
International Water Power and Dam Construction IWPCDM, No. Suppl, p 8-10, 1990. 10 fig, 5 ref.

Descriptors: *Design standards, *Hydraulic turbines, Comparison studies, Energy equation, Flow

equations, Graphical analysis, Parametric hydrology, Regression analysis, Specific head, Statistical analysis, Velocity.

A research study has been carried out on small water turbines, using the data collected from various manufacturers and other sources. Basic hydraulic and geometric parameters surveyed include specific speed, available head, energy and flow coefficients, and specific diameter. A statistical evaluation shows results graphically and analytically as regression functions, and can be used for quick estimation of the basic small turbine parameters. The regression functions together with the statistical curves yield the average value of hydraulic and geometric parameters of the best efficiency points pertaining to the individual units. These graphs indicate the general trend in the design of small turbines. In addition, the results can be used as a statistical pointer to the future development of these machines. (Author's abstract)
W90-08331

DIAGNOSTIC TOOLS FOR SMALL HYDRO DEVELOPMENTS.
Agence Francaise pour la Maitrise de l'Energie, Paris.
F. Armand, and L. Monition.
International Water Power and Dam Construction IWPCDM, No. Suppl, p 12-13, 1990. 1 fig.

Descriptors: *Computer programs, *Databases, *Feasibility studies, *Hydroelectric plants, Civil engineering, France, Hydraulic engineering, Hydraulic turbines, Resources development.

AFME (Agence Francaise pour la Maitrise de l'Energie), a French public institution is in charge of the development of concerted public actions in the field of energy conservation and rational uses of energy and also promotes new and renewable energies, especially small hydro developments. AFME supports diagnostic tools which give an initial estimate of the value of the project, such as a computerized data bank and engineering software. The PROPHETE data bank, created by the Bureau de Recherches Geologiques et Minieres, helps to define the optimum flow, according to the seasonal sales tariff system, and to calculate income, in the case of purchase by Electricite de France, or savings, if the energy is to be used by the producer. Engineering software developed by Centre Technique des Industries Mecaniques gives information on the electromechanical equipment to be provided. It defines the main dimensions of the machine and estimates equipment costs. To give easy access to the PROPHETE data bank and the engineering project software, a simplified version of the software has been installed on the Minitel video text system, accessible from each of the four million phone-linked video text terminals in France. Software that can draw Francis turbines reduces appreciably the time spent at the drawing board. Software for the drawing of Kaplan turbines is now being studied. PEACH software, developed by ISL Consultants specifically for civil engineering calculations, can be a great help in the preparation of feasibility studies. A major advantage is that it can be used on portable microcomputers, enabling preliminary cost and financial analyses to be carried out in the field. By supporting such software programs, the AFME is contributing significantly to the development of small hydroelectric plants. (Fish-PTT)
W90-08332

MICRO HYDRO FOR AN ISOLATED RURAL WATER SUPPLY.
Leyland Consultants Ltd., Auckland (New Zealand).
P. H. J. Caplen.
International Water Power and Dam Construction IWPCDM, No. Suppl, p 13-14, 1990. 1 fig.

Descriptors: *Developing countries, *Hydroelectric power, *Rural areas, *Water supply development, Civil engineering, Electrical equipment, Hydraulic turbines, Pump turbines, South Pacific Islands.

Remote villages in the highlands of the South Pacific island of Vanuatu are to receive a pumped

water supply. The pumps will be driven by a micro hydro scheme sited in an adjacent valley. Because the output of the micro hydro scheme will be limited in the dry season, a variable speed self-governing system was adopted. The efficiencies of the turbine, generator, transmission system, driving motors and pumps were critical and yet the system had to work even if all the uncertain factors were unfavorable. Two pumps were chosen instead of one to aid starting and so that during exceptionally low flow periods the turbine could be cut back to one jet still able to power one pump. Components are now being ordered and construction is expected to begin shortly. (Fish-PTT)
W90-08333

RR-TYPE LOW-HEAD PROPELLER TURBINE.
JV International, Wijhe (Netherlands).
B. Berkenbosch, and M. van Gastel.
International Water Power and Dam Construction IWPCDM, No. Suppl, p 16-17, 1990. 4 fig.

Descriptors: *Hydraulic turbines, *Hydroelectric plants, *Water supply development, Civil engineering, Construction methods, Design criteria, Flooding, Mechanical engineering, Propellers, Radial gates.

An extensive field survey of low-head micro hydro plants was made between 1984 and 1986. Existing plants with various types of turbines in several developing countries were evaluated. It was found that: low-head turbines tended to imply large volumes and often large weights, which can cause transport and handling problems; poorly regulated rivers caused frequent flooding and large head variations; and, competitive schemes demanded a turbine design that allows cheap civil works. The research led to the development of the RR-type turbine: essentially a propeller turbine with a vertical axis and a compact spiral casing. The radial valve between the guidevanes and the propeller and the radial diffuser are somewhat unusual elements. The mechanical design concept is that the turbine is completely steel-fabricated and largely preassembled at the workshop so that critical alignments at the construction site do not occur. It is shipped in only three parts and, as a result, can be constructed and commissioned at the site in only one week. (Fish-PTT)
W90-08334

SIAH BISHE PUMPED-STORAGE PROJECT IN IRAN.
Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
E. Failer, and H. Bayat.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 4, p 13-18, April 1990. 6 fig.

Descriptors: *Hydroelectric plants, *Iran, *Pumped storage, *Rockfill dams, *Water supply development, Civil engineering, Electrical equipment, Spillways.

The Siah Bishe pumped storage project, with an installed capacity of 4 x 250 MW, will be Iran's first pumped storage scheme. At present under construction and scheduled for commissioning in 1996, the power plant will provide a daily peak energy of 4000 MWh, considerably improving the performance of the integrated power system of Iran. The main civil structures of this project include: two concrete-faced rockfill dams, including chute spillways and diversion/bottom outlets; the power intakes, waterways, and outlets; and, an underground powerhouse and transformer cavern. The detailed design will be completed in mid-1990. (Author's abstract)
W90-08335

DESIGN OF CHINA'S MING TOMBS PUMPED-STORAGE SCHEME.
Ministry of Water Resources and Electric Power, Beijing (China). Information Research Inst.
For primary bibliographic entry see Field 8A.
W90-08336

PUMP-TURBINE REFURBISHMENT AT THE SALINA POWERHOUSE.
Voith Hydro, Inc., York, PA. Rehabilitation Services.
J. L. Kepler, and K. T. McGaughey.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 4, p 26-28, April 1990. 4 fig, 2 tab.

Descriptors: *Hydraulic machinery, *Maintenance, *Oklahoma, *Pump turbines, Cost repayment, Cost-benefit analysis, Francis turbines, Gates, Rehabilitation.

A pump turbine for the Grand River Dam Authority at its Salina, Oklahoma, plant was rehabilitated. The powerhouse contains six Francis reversible pump turbines, which had deteriorated considerably since their installation in 1967. Excessive unit runout was noted, along with significant guidevane vibration and movement. Major specific problems observed before disassembly were: a broken lower rotating wearing ring, excessive gate end seal wear, excessive gate vertical seal clearance, guidevane bushing wear, and hydraulic surface irregularities of the runner. The major reasons for deterioration could be attributed to the overlay of welding repairs without surface contour grinding. The headcovers and bottom ring required line-boring and repair with stainless steel. A complete new set of gate-end seal assemblies was provided. All the hydraulic surfaces of the guidevanes were repaired with stainless steel. All the wearing rings were replaced, machined, and aligned correctly. The bearing pads of the regulating ring were replaced. The link bushings of the guidevane were all replaced. The servomotor piston rings and packings were replaced. The refurbished unit is now back in service and its capacity has been increased by 4 MW. Major rehabilitation efforts will always produce positive results; considering the normal downtime of six to seven months for this magnitude of work, the payback and reduced maintenance over the next 10 to 15 years is favorable. (Fish-PTT)
W90-08337

RECOMMENDATIONS ON THE DESIGN OF STEEL LININGS FOR PENSTOCKS.
S. Jacobsen.
International Water Power and Dam Construction IWPCDM, Vol. 42, No. 4, p 44-47, April 1990. 1 fig.

Descriptors: *Hydroelectric plants, *Materials engineering, *Penstocks, *Steel, *Tunnel linings, Construction methods, Design standards, Nondestructive tests, Pressure distribution.

The recent design and construction of several high-head hydroelectric powerplants with large steel linings has shown that some designers of such steel linings are unaware of dangers which can be associated with application of the well known Amstutz formulae. These problems arise from differing calculations of penstock design to withstand the external buckling pressure; the critical Amstutz pressure is the same for narrow or widely spaced stiffener rings. Recommendations for the designer are: (1) to remember that external pressure is more dangerous than internal pressure; (2) drainage systems should not be trusted; (3) the welding efficiency factor should be forgotten; (4) penstock welding must be of excellent quality; (5) weldings should also be checked during production and erection; (6) Normal Welding Procedure Tests and Welder Qualification Tests are usually of little value; (7) all welders should have not only passed a qualification test, but should have passed a test which simulates production welding; (8) testing of the welding coupons should comprise nondestructive and destructive tests; (9) an allowance in thickness of 1 mm or more for corrosion resistance is not necessary with today's painting systems; and (10) limit contact grouting should be limited to a minimum, mainly in the horizontal sections. (Fish-PTT)
W90-08339

DESIGN OF HYDRAULIC JUMP CHAMBERS.

Field 8—ENGINEERING WORKS

Group 8C—Hydraulic Machinery

Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W90-08353

XIANGTAN Q-TYPE AUTOMATIC HYDRAULIC FLAP GATE.
Xiangtan City Water Resources and Hydropower Bureau (China).
For primary bibliographic entry see Field 3F.
W90-08358

DOWNSTREAM EFFECTS OF INTERMITTENT POWER GENERATION.
Biological Station, Lunz am See (Austria).
For primary bibliographic entry see Field 6G.
W90-08622

8D. Soil Mechanics

HYDROLOGY OF THE CASTLE LAKE BLOCKAGE, MOUNT ST. HELENS, WASHINGTON.
Geological Survey, Tacoma, WA. Water Resources Div.
W. Meyer, and M. Sabol.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 87-4272, 1989. 25p, 16 fig, 3 tab, 5 ref.

Descriptors: *Castle Lake, *Dam safety, *Earth dams, *Floods, *Hydrologic models, *Mount St Helens, *Volcanoes, *Washington, Flooding, Groundwater movement, Piping.

The debris avalanche during the May 18, 1980, eruption on Mount St. Helens, Washington, blocked South Fork Castle Creek, creating Castle Lake. Stability of the blockage against failure was of concern, and a digital model was constructed to simulate groundwater movement in the blockage. The model simulates seasonally high water levels, recharge and discharge, and provides a means to estimate hydraulic gradients in the blockage. Recharge from precipitation accounts for approximately 81% of the total recharge to the blockage during the calibration period of the model, and 81% of discharge from the blockage occurs as seeps. Groundwater levels under the crest of the blockage are higher than lake levels. Water movement is downward and horizontal under the blockage crest and upward under Castle Lake and the blockage toe. (USGS)
W90-07859

STABILITY OF SOIL AGGREGATES IN RELATION TO ORGANIC CONSTITUENTS AND SOIL WATER CONTENT.
Canterbury Agriculture and Science Centre (New Zealand).
For primary bibliographic entry see Field 2G.
W90-07996

DIRECTIONAL STRENGTH IN AGGREGATES AS AFFECTED BY AGGREGATE VOLUME AND BY A WET/DRY CYCLE.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
For primary bibliographic entry see Field 2G.
W90-07997

SIAH BISHE PUMPED-STORAGE PROJECT IN IRAN.
Lahmeyer International G.m.b.H., Frankfurt am Main (Germany, F.R.).
For primary bibliographic entry see Field 8C.
W90-08335

8E. Rock Mechanics and Geology

INTEGRATED SEISMIC RISK ANALYSIS FOR EARTH DAMS.

Northeastern Univ., Boston, MA. Dept. of Civil Engineering.
M. K. Yegian, E. A. Marciano, and V. G. Ghahraman.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-207773. Price codes: A06 in paper copy, A01 in microfiche. Report No. CE-88-15, December 1988. 142p, 24 fig, 17 tab, 75 ref, 6 append. NSF Grant DFR-8412124.

Descriptors: *Dam failure, *Earth dams, *Risk assessment, *Seismic waves, Earthquake engineering, Prediction, Probabilistic process.

To evaluate the overall seismic risk of damage to or failure of earth dams an Integrated Seismic Risk Analysis procedure was developed. The analysis combines the probabilistic prediction of occurrence of seismic events with probabilistic prediction of the performance of a dam experiencing these events and provides estimates of seismic risk. Techniques were employed to express the Seismic Hazard Analysis results in terms of joint occurrence of peak ground acceleration and earthquake magnitude or associated number of equivalent cycles. Furthermore, a probabilistic procedure for the calculation of permanent deformation of earth dams was developed in which the seismic event is characterized in terms of acceleration, number of cycles and predominant period of motion. The application of these procedures provides estimates of relative risks, which are useful in design and decision analysis, where trade-offs are made between the cost of increasing the seismic resistance and the risks associated with the consequences of seismic damage. In addition, risk-based safety evaluation enables identification of the most important parameters, assumptions, hypotheses and safety criterion affecting the evaluation of the safety of the dam and avoids compounding of conservatism. (Author's abstract)
W90-07513

ROCK MASS CHARACTERIZATION FOR DAM FOUNDATIONS.
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
B. A. Chappell.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 116, No. 4, p 625-646, April 1990. 9 fig, 8 tab, 12 ref.

Descriptors: *Dam foundations, *Geologic fractures, *Rock mechanics, *Rock properties, Australia, Bedrock, Civil engineering, Rock mass anisotropy, Statistical analysis, Thomson Dam.

Classification systems define rock mass zones that represent the potential behavior of the rock mass when subjected to load changes. Rock mass characterization, as opposed to rock mass classification, is described by an example of the right-abutment ridge, Thomson Dam, Australia. Geological investigations demarcate the discontinuities into sets covering specific zones or domains. Samples from these rock zones are retrieved and indexed and the zones are then bounded and classified. From selected sites, discontinuity samples are retrieved and laboratory-tested for strength and stiffness. Rock material moduli and joint stiffness are combined using two simple models representing the constraints of equilibrium and compatibility, and produce the predicted rock mass' anisotropic moduli. Measured in situ rock mass moduli are compared with predicted moduli. Of the various discontinuity types, the bedding plane thrust have the lowest strengths and greatest deformational potential. Fault gouge and its association with clay content control the friction angle and deformability potential. (Author's abstract)
W90-07595

FRACTURE CONTROLS ON CONDUIT DEVELOPMENT.
For primary bibliographic entry see Field 2F.
W90-08552

8F. Concrete

CONCEPTS FOR INSTALLATION OF THE PRECAST CONCRETE STAY-IN-PLACE FORMING SYSTEM FOR LOCK WALL REHABILITATION IN AN OPERATIONAL LOCK.
Berger/Abam Engineers, Inc., Auburn, WA.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report REMR-CS-28, December 1989. Final Report. 211p, 18 fig, 6 tab, 4 ref, 6 append. Army Corps of Engineers Contract DACW39-86-C-0014.

Descriptors: *Concrete construction, *Hydraulic structures, *Locks, *Maintenance, *Precast concrete, Cofferdams, Costs, Design standards, Underwater.

In an operational lock, it is not possible to dewater or lower the tailwater level, and thus, some wall rehabilitation work must be performed underwater. In addition, it is necessary for the work to be coordinated around scheduled lock openings, and all ancillary lock equipment must be maintained in an operational condition. During this study, operational and design criteria were developed to serve as the basis for design. A number of repair concepts were identified that satisfied the criteria. Schedule and cost estimates were prepared for the various concepts that served as the basis for selection of a preferred concept. An installation procedure using a cofferdam was selected as the preferred repair method. The design included the preparation of drawings and specifications for the repair of a generic lock to demonstrate the various aspects of the repair procedure. Cost and schedule assessments were part of this work. The results of this developmental effort suggest that it is feasible to repair deteriorated navigation lock walls in an operational lock with only minor impact on costs. For the generic 600-ft-long by 110-ft-wide lock, repair costs were estimated at $140/sq ft and would require 16 weeks for completion, assuming 5-day work weeks with 12-hr days. Although the concepts described were developed specifically for installation of stay-in-place forms in an operational navigation lock, they are potentially applicable to other concrete walls requiring repair under water. Potential applications include tailrace wingwalls, floodwalls, and stilling basin walls. (Lantz-PTT)
W90-07510

8G. Materials

ASTM STANDARDS ON GEOTEXTILES.
American Society for Testing and Materials, Philadelphia, PA.
ASTM, Philadelphia, Pennsylvania. 1988. 65p.

Descriptors: *Geotextiles, *Liners, *Materials testing, *Reservoir linings, *Standards, Polymers, Strength, Temperature, Transmissivity.

This 'standards' volume contains 18 standards, including specifications, test methods, practices, and terminology, covering mechanical, endurance, permeability, and filtration properties. This compilation is intended as a technical resource for civil, geotechnical, environmental, and structural engineers, as well as manufacturers and suppliers of geosynthetic materials. Specifications are given for polyethylene and ethylene copolymer plastic sheeting, flexible poly(vinyl chloride), vulcanized rubber sheeting, and fabric-reinforced, vulcanized rubber sheeting for pond, canal, and reservoir lining. Test methods are presented for: (1) water permeability of geotextiles by permittivity; (2) trapezoid testing strength of geotextiles; (3) effects of temperature on stability of geotextiles; (4) tensile properties of geotextiles by the wide-width strip method; (5) breaking load and elongation of geotextiles (grab method); (6) constant head hydraulic transmissivity (in-place flow) of geotextiles and geotextile related products; (7) determining apparent opening size of a geotextile; and (8) index puncture resistance of geotextiles, geomembranes, and related products. (Lantz-PTT)
W90-07560

PERFORMANCE OF MATERIALS USED IN SEAWATER REVERSE OSMOSIS PLANTS.
Kuwait Inst. for Scientific Research, Safat.
For primary bibliographic entry see Field 3A.
W90-08042

CORROSION RESISTANT MATERIALS FOR SEAWATER RO PLANTS.
Saline Water Conversion Corp., Al-Jubail (Saudi Arabia). Research, Development and Training Center.
For primary bibliographic entry see Field 3A.
W90-08046

FACTORS AFFECTING THE CORROSION BEHAVIOUR OF CN 108 ALLOY IN SEA WATER.
Rome-2 Univ. (Italy). Dept. of Chemical Science and Technology.
For primary bibliographic entry see Field 3A.
W90-08053

GEOTEXTILE TESTING AND THE DESIGN ENGINEER.
ASTM Special Technical Publication 952, 1987. American Society for Testing and Materials, Philadelphia, PA. 183p. Edited by Joseph E. Fluet.

Descriptors: *Design standards, *Geotextiles, *Materials testing, Design criteria, Textiles.

Geotextiles have been defined by ASTM Committee D35 on Geotextiles, Geomembranes, and Related Products as 'permeable textiles used with geotechnical materials as an integral part of a manmade project, structure or system.' Geotextiles are part of a larger family of materials called geosynthetics, which are used by civil, geotechnical, environmental, and structural engineers in their designs. More than 200 million sq m of geosynthetics are now being sold per year in North America, and the market is growing at roughly a 15-20% annual rate of increase. This rapid growth has been plagued with many of the problems which beset any emerging discipline, and one problem which has been particularly troublesome is interdisciplinary communications. Of necessity, the geosynthetic discipline has representation from civil, geotechnical, environmental, structural, industrial, mechanical, chemical, textile, and plastics engineering, as well as the scientific fields of chemistry, biology, physics, and others. This 'Special Technical Publication' (STP) attempts to address this communication problem by discussing both the textile industry tests and the relevance of those tests to the design engineers. The tests are grouped by the broad types of properties which measure--mechanical, hydraulic, and endurance--and each category is followed by papers which describe the relevance of the test results to the design engineer. Additionally, there is a section on the future of geosynthetic tests and applications, which shows clearly that, although we have come very far, there is still a long way to go. One other highlight of this STP is the ASTM position paper which is intended as an interim guide for those laboratories which cannot wait for the publication of ASTM standards which are currently under development. (See W90-08127 thru W90-08134) (Lantz-PTT)
W90-08126

HYDRAULIC PROPERTIES OF GEOTEXTILES.
Tensar Corp., Morrow, GA.
R. G. Carroll.
IN: Geotextile Testing and the Design Engineer. ASTM Special Technical Publication 952, 1987. American Society for Testing and Materials, Philadelphia, PA. p 7-20, 5 fig, 1 tab, 10 ref.

Descriptors: *Geotextiles, *Hydraulic properties, *Materials testing, Drainage, Filtration, Geosynthetic materials, Laboratory methods, Pore size, Porosity, Standards.

Hydraulic properties of geotextiles are controlled by the geotextiles' pore sizes, pore size distribution, and porosity. Because porometry characteristics of fabric are difficult to measure precisely, index tests have been developed that relate other fabric char-

acteristics to hydraulic performance. Apparent opening size, permittivity, gradient ratio, and transmissivity are hydraulic properties currently being used as performance criteria for geotextiles. ASTM Committee D-35 on Geotextiles, Geomembranes, and Related Products is developing standard procedures for characterizing these properties. (See also W90-08126) (Author's abstract)
W90-08127

GEOTEXTILES AND DRAINAGE.
New York State Dept. of Transportation, Albany.
L. D. Suits, and T. P. Hoover.
IN: Geotextile Testing and the Design Engineer. ASTM Special Technical Publication 952, 1987. American Society for Testing and Materials, Philadelphia, PA. p 21-32, 3 fig, 1 tab, 4 ref.

Descriptors: *Drainage, *Geotextiles, *Materials testing, Construction materials, Design criteria, Design standards, Filtration, Geosynthetic materials, Institutional constraints, Management planning, Standards.

The use of geotextiles in geotechnical engineering has brought about many theories and approaches varying from a broad-based general requirement to a project-by-project design approach. The methods of selection and testing, and the recommended use of geotextiles for drainage applications as defined by the New York State Department of Transportation (NYS DOT) and the California Department of Transportation (Caltrans) are presented. Caltrans approaches the use of geotextiles for drainage in the same manner as they approach aggregate filtration for drainage, with the advantages of a filter with tensile properties being incorporated. The Caltrans Standard Specifications address geotextile use from a range of properties associated with drainage rather than singular absolute parameters. Caltrans approaches geotextile acceptance on a project-by-project basis. While accepting letters of certification concerning geotextile properties, they also carry on a general control testing program for acceptance. NYS DOT addresses the use of geotextiles from a preapproved list of materials of five basic categories. This concept provides the basis for NYS DOT use of geotextiles in normal (that is, nonsevere) applications. Therefore, the contractor has a choice of several geotextiles based on availability, economics, and experience in use. Specific design considerations are required in two critical applications: (1) use in an underdrain application, in which soil retention, permittivity and strength are important; and (2) use as slope protection, in which friction is most important, followed by soil retention, permittivity and strength. Both agencies have limited drainage applications to nonwoven materials, and through differing empirical approaches both agencies have developed cost-effective and efficient usage of geotextiles in drainage applications. (See also W90-08126) (Author's abstract)
W90-08128

LATERAL DRAINAGE DESIGNS USING GEOTEXTILES AND GEOCOMPOSITES.
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
R. M. Koerner, and J. A. Bove.
IN: Geotextile Testing and the Design Engineer. ASTM Special Technical Publication 952, 1987. American Society for Testing and Materials, Philadelphia, PA. p 33-44, 7 fig, 2 tab, 8 ref.

Descriptors: *Design standards, *Drainage engineering, *Geotextiles, *Hydraulic properties, *Lateral drainage, Drainage, Flow pattern, Geosynthetic materials, Transmissivity.

Of the available properties that geosynthetic materials possess, their ability to conduct liquids in the plane of their structure is important in a wide class of drainage applications. The thicker geotextiles (usually needled nonwoven types) and a new generation of high drainage composite materials are most suitable for this purpose. The required data base for determining the transmissivity or flow rate of geotextiles and geocomposites comes from laboratory measurements on the materials in question. Work of this type has been published for geotex-

tiles and is further reviewed in this publication. From this data, a number of observations can be noted: (1) all fabrics (nonwoven-heat set, woven-slit film, woven-monofilament, and nonwoven-needled) show an exponentially decreasing trend due to initial compression of these lofty fabrics at low stresses; (2) all fabrics show a nearly constant transmissivity value at stresses higher than approximately 19 kPa where the fiber structure is sufficiently dense to support the applied stress; (3) this constant, and residual, value is in the range of 0.4 to 1.4 cu micrometers/sec-m, which is the value to be generally used in design; (4) there is considerable crossover of trends in the data from the various geotextiles that were tested; and (5) there is a general trend that the heavier and/or thicker geotextiles have the highest transmissivity. Three examples illustrate these observations through presentations of: (1) a gravity drainage design using a geotextile against a seeping soil slope; (2) a pressure drainage design for use of a geotextile under a soil surcharge fill; and (3) a geocomposite drain placed behind a cantilever retaining wall. (See also W90-08126) (Lantz-PTT)
W90-08129

GEOTEXTILES AS FILTERS IN EROSION CONTROL.
Chemie Linz U.S., Incl, Golden, CO 80401.
For primary bibliographic entry see Field 4D.
W90-08130

REVIEW OF EXISTING GEOTEXTILE TENSION TESTING METHODS.
B. Myles.
IN: Geotextile Testing and the Design Engineer. ASTM Special Technical Publication 952, 1987. American Society for Testing and Materials, Philadelphia, PA. p 57-68, 12 fig.

Descriptors: *Geotextiles, *Laboratory methods, *Materials testing, *Stress analysis, *Tension, Geosynthetic materials, Tensile stress.

The review assesses geotextile tension testing procedures in both North America and Europe with particular reference to the difference between the conditions of local and total stress imposition. The tests discussed are: (1) Grab test; (2) California Bearing Ratio (CBR); (3) Cylindrical sleeve (Saint-Brieuc); (4) Circular or rectangular burst test; (5) Crucifix biaxial test; (6) Strip tension test; and (7) Laterally restrained tension test. The importance of the failure mode and fabric structure integrity under stress are highlighted. The wide variation in the current test procedures would seem to indicate a great diversity of philosophies or parameters and property requirements. This is not the case in practice. Rather, there has emerged basically two types of tests; (1) a localized loading test giving a good empirical indication as to the robustness of the geotextile and its ability to function as a separator (CBR or Grab tests); and (2) a unidirectional loading test giving an indication of the stress/strain characteristics and the ability to develop a tensile load. All geotextile testing results should be presented in the form of a mean and standard deviation. The results can be presented in the form of a maximum load or breaking load with approximate extensions, or they can be presented in graph form which shows in more detail the stress/strain behavior. In addition to the breaking load and breaking extension, or maximum load and maximum extension, an appropriate modulus should be defined. To be meaningful, the elastic response function (modulus) must relate to the predicted work stress/strain range of the geotextile which, in turn, must take into account the possible and acceptable soil strain. (See also W90-08126) (Lantz-PTT)
W90-08131

SOIL REINFORCEMENT DESIGN USING GEOTEXTILES AND GEOGRIDS.
GeoServices, Inc., Boynton Beach, FL.
For primary bibliographic entry see Field 4D.
W90-08132

GEOTEXTILES CONSTRUCTION CRITERIA.

Group 8G—Materials

Soil and Material Engineers, Inc., Cary, NC.
G. N. Richardson, and D. C. Wyant.
IN: Geotextile Testing and the Design Engineer.
ASTM Special Technical Publication 952, 1987.
American Society for Testing and Materials, Philadelphia, PA. p 125-138, 5 fig, 3 tab, 12 ref.

Descriptors: *Construction materials, *Design criteria, *Geotextiles, Design standards, Drainage, Erosion control, Failure, Limiting factors, Performance evaluation, Soil stabilization.

Designers of geotextile systems must place greater emphasis on a review of construction criteria compared to typical civil engineering design. This enhanced awareness is necessitated by the lack of significant construction experience in the use of these materials by most contractors and field personnel. Common installation criteria associated with fabric survivability are reviewed as are the four major roles played by geotextiles: (1) drainage; (2) erosion control; (3) separation; and (4) reinforcement. Construction-related problems common to the use of geotextiles can generally be associated with the following conditions: (1) field fill placement or compaction techniques damage the geotextile; (2) installation loads are significantly in excess of design loads, leading to failure during construction; (3) construction environment leads to a significant reduction in assumed fabric properties, causing a failure of the completed project; (4) field seaming or overlap of the geotextile fails to fully develop desired fabric mechanical properties; and (5) instabilities during various construction phases may render a design inadequate even though the final profile would have been stable. Both general geotextile and construction criteria developed to minimize field installation problems are reviewed. Field inspection by a qualified engineer must be considered vital to the successful installation in all performance models. (See also W90-08126) (Lantz-PTT)
W90-08133

TOMORROW'S DESIGNS FOR GEOTEXTILE APPLICATIONS.
GeoServices, Inc., Boynton Beach, FL.
J. P. Giroud.
IN: Geotextile Testing and the Design Engineer.
ASTM Special Technical Publication 952, 1987.
American Society for Testing and Materials, Philadelphia, PA. p 145-158, 5 fig, 14 ref.

Descriptors: *Design criteria, *Geotextiles, *Materials testing, Drainage, Filters, Geosynthetic materials, Prediction, Soil stabilization.

A review of existing design methods for selected geotextile applications such as filtration, drainage, and unpaved roads shows that these applications can be designed using rational methods: (1) identify the mechanisms through which the geotextile is expected to perform in the considered application, and identify geotextile properties governing these mechanisms; and (2) determine the required values of the geotextile properties by using a method of design. This two-step approach is used for three typical applications: geotextile filters, geosynthetic drains, and geosynthetic-reinforced unpaved roads. A brief prediction concerning what geotechnical engineers in the future will be able to construct, and with what materials is briefly outlined. Materials will range from currently available geosynthetics to microgeosynthetics and biogeoproducts (products with controlled growth in size and orientation). New methods will open up, especially for soil reinforcement, such as macroreinforcement through pretensioning. (See also W90-08126) (Lantz-PTT)
W90-08134

8I. Fisheries Engineering

SOME OBSERVATIONS ON SEASONAL VARIATION OF RADIO-CESIUM CONTAMINATION IN TROUT (SALMO TRUTTA L.) AND ARCTIC CHAR (SALVELINUS ALPINUS (L.)) IN A NORWEGIAN LAKE AFTER THE CHERNOBYL FALLOUT.
Norges Tekniske Hoegskole, Trondheim.

For primary bibliographic entry see Field 5B.
W90-07693

IMPACT OF INTENSIVE CAGE FISH FARMING ON THE PHYTOPLANKTON AND PERIPHYTON OF A SCOTTISH FRESHWATER LOCH.
Stirling Univ. (Scotland). Inst. of Aquaculture.
For primary bibliographic entry see Field 5B.
W90-07719

CHANGES IN FISH COMMUNITIES AND BIOMANIPULATION IN WATER SUPPLY RESERVOIRS.
Vyzkumny Ustav Rybarsky Vodnany (Czechoslovakia). Reservoir and River Lab.
For primary bibliographic entry see Field 2H.
W90-07765

DEVELOPMENT OF THE ICHTHYOFAUNA OF THE RIMOV RESERVOIR AND ITS MANAGEMENT.
Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.
For primary bibliographic entry see Field 2H.
W90-07768

ORIGIN, COMPOSITION AND YIELD OF FISH IN RESERVOIRS.
Waterloo Univ. (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-07770

MONITORING FLORIDA'S RIVERINE FISH COMMUNITIES.
Florida Game and Fresh Water Fish Commission, Holt. Blackwater Fisheries Research and Development Center.
D. G. Bass.
Florida Scientist FLSCAQ, Vol. 53, No. 1, p 1-10, Winter 1990. 8 fig, 13 ref. Wallop-Breaux Federal Aid Project F-36.

Descriptors: *Fish management, *Fish populations, *Florida, *Rivers, Biological studies, Biomass, Monitoring, Population dynamics, Species composition.

Fishes of 11 Florida rivers were sampled annually to determine relative abundance, biomass and species richness. The goal of this program was to create a statewide catalog of riverine fish resources and to provide a mechanism for detecting long-term trends in fish populations and communities. Both increases and declines of abundance and biomass were observed in some rivers and baseline data for continued monitoring were established. Current results point at present (Peace River) or potential (Choctawhatchee River) trouble spots throughout the state, but do not suggest overall, statewide declines on riverine fish resources. Several more years of survey will be necessary to determine whether current trends are merely artifacts of short-term population cycles or represent real long-term directions in fish abundance, biomass, or species richness. (Sand-PTT)
W90-07876

POLLUTION FROM FISH FARMS.
For primary bibliographic entry see Field 5B.
W90-07928

RELATIONSHIP BETWEEN FEEDING INCIDENCE AND VERTICAL AND LONGITUDINAL DISTRIBUTION OF RAINBOW SMELT LARVAE (OSMERUS MORDAX) IN A TURBID WELL-MIXED ESTUARY.
Laval Univ., Quebec. Dept. de Biologie.
For primary bibliographic entry see Field 2L.
W90-07938

ZOOPLANKTON COMMUNITY CHANGES IN LAKE KINNERET (ISRAEL) DURING 1969-1985.
Kinneret Limnological Lab., Tiberias (Israel).

For primary bibliographic entry see Field 2H.
W90-08070

IMPACT OF CYPRINIDS ON ZOOPLANKTON AND ALGAE IN TEN DRAINABLE PONDS.
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 2H.
W90-08092

RESTORATION BY BIOMANIPULATION IN A SMALL HYPERTROPHIC LAKE: FIRST-YEAR RESULTS.
Water Board of Utrecht (Netherlands).
For primary bibliographic entry see Field 5G.
W90-08093

RISKS OF TOXIC CONTAMINANTS TO EXPLOITED FISH POPULATIONS: INFLUENCE OF LIFE HISTORY, DATA UNCERTAINTY AND EXPLOITATION INTENSITY.
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W90-08243

TOXICITY OF ORGANIC SELENIUM IN THE DIET TO CHINOOK SALMON.
National Fisheries Contaminant Research Center, Yankton, SD. Field Research Station.
For primary bibliographic entry see Field 5C.
W90-08246

STRIKING A BALANCE IN THE PACIFIC NORTHWEST.
Oregon State Univ., Corvallis. Dept. of Geosciences.
K. W. Muckleston.
Environment ENVTAR, Vol. 32, No. 1, p 10-15/32-36, January/February 1990. 6 fig, 50 ref.

Descriptors: *Columbia River, *Dam effects, *Fish conservation, *Fish passages, *Hydroelectric power, *Multiobjective planning, *Regional planning, *Resources management, *Snake River, Dams, Fish populations, Northwest Power Planning Council, Pacific Northwest, River basin development, Salmon, Water use, Wildlife management.

In the Pacific Northwest, dams built to generate hydroelectricity have cut annual salmon runs on the Columbia and Snake Rivers to 15 to 25 percent of their previous numbers. Three developments encouraged hydropower production at the expense of salmon: the 1964 Columbia River Treaty, the 30 year Pacific Northwest Coordination Agreement, and the completion of the Pacific Northwest-Southwest Intertie. The Northwest Power Planning Council (NPPC) was formed to plan for an adequate, efficient, economic, and reliable power supply for the region, and for correction of past losses, and future protection of fish and wildlife, especially salmonids, in the Columbia River basin. The NPCC's fish and wildlife program attends to salmon reproduction, harvest, habitat improvement, designation of sanctuary streams protected from future hydroelectric development, and improvement of fish passage on the mainstem Columbia-Snake system. NPPC's water budget provides for the partial restoration of freshets that would have occurred in the absence of upstream storage dams when rates of discharge fall below levels considered satisfactory for smolt passage during the principal downstream migration period. Spill, another technique in the NPPC program to improve survival rates of smolts, provides a fish passage route away from the turbines. (MacKeen-PTT)
W90-08290

BIOLOGY OF BAIKAL OMUL, COREGONUS AUTUMNALIS MIGRATORIUS, IN BRATSK RESERVOIR.
Institute of Fisheries Research and Management, Ulan-Ude (USSR).

O. A. Polyakov.
Journal of Ichthyology JITHAZ, Vol. 29, No. 5, p 40-46, 1989. 6 tab, 23 ref. Translated from Voprosy Ikhtiologii, No. 3, p 416-422, 1989.

Descriptors: *Fish populations, *Reservoir fisheries, *Reservoirs, *Whitefish, Bratsk Reservoir, Fish growth, Fish physiology, Fish stocking, Lake Baikal, USSR.

The morphology, age, size, weight, reproduction, and fecundity of Baikal omul, Coregonus autumnalis migratorius, were studied in specimens from the Bratsk Reservoir in the Soviet Union. A total of 4045 specimens were collected with nets and seines in the Belaya River, a tributary of the Bratsk Reservoir, where the most abundant spawning population was recorded. Males had thicker paired and dorsal fins, greater head depths, and greater caudal peduncle length, while females had greater body depths and thickness. The spawning population consisted of 3+ to 9+ age fish. Compared with specimens from Lake Baikal, omul from the Bratsk reservoir had higher growth rate, earlier sexual maturity, and higher fecundity. Morphological differences in number of gillrakers, caudal peduncle length, and postdorsal distance were also noted between omul from the Bratsk Reservoir and the parent stock from Lake Baikal. The author concludes that Bratsk omul may be used for stocking other bodies of water, especially new reservoirs. (MacKeen-PTT)
W90-08291

AMUR BREAM, PARABRAMIS PEKINESIS, IN THE AMU DARYA LOWLAND WATER BODIES.
Karakalpakskii Kompleksnyi Nauchno-Issledovatelskii Inst., Nukus (USSR).
I. M. Zholdasova, L. N. Guseva, and E. Adenbag.
Journal of Ichthyology JITHAZ, Vol. 29, No. 5, p 71-78, 1989. 6 fig, 1 tab, 19 ref. Translated from Voprosy Ikhtiologii, No. 3, p 475-482, 1989.

Descriptors: *Acclimatization, *Amu Darya River, *Fish populations, *Lake fisheries, Amur River, Fish food, Fish growth, Fish physiology, River basins, USSR.

The distribution of the self-acclimatized species Amur bream, Parabramis pekinesis, was studied in the Amu Darya basin. A total of 119 adult fish caught in passive nets were examined. P. pekinesis from the Amu Darya basin did not differ significantly from those from the natural habitat in mean

length and weight. Food of juvenile P. pekinesis in the Amu consisted mainly of algae and rotifers; that of adult fish consisted of vascular plants and algae. The absolute fecundity of 5 to 8 year old females in the new habitats was 83.4 to 369 thousand eggs. The sex ratio approximated one to one. In the Amu Darya basin, the first maturing females recorded were 5 years old, and 6+ females had an average maturity index of 18.23%. Males were observed to mature at 2+. The authors conclude that the lakes of the Amur Darya lowlands provide favorable conditions for acclimatization of P. pekinesis. (MacKeen-PTT)
W90-08292

EFFECT OF NUTRIENT ADDITIONS ON LOWER TROPHIC LEVELS OF AN OLIGO-TROPHIC LAKE WITH A SEASONAL DEEP CHLOROPHYLL MAXIMUM.
Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.
For primary bibliographic entry see Field 2H.
W90-08433

CHANGES IN THE ZOOBENTHOS COMMU-NITY OF ACIDIFIED BOWLAND LAKE AFTER WHOLE-LAKE NEUTRALIZATION AND LAKE TROUT (SALVELINUS NAMAY-CUSH) REINTRODUCTION.
Ontario Ministry of the Environment, Sudbury.
For primary bibliographic entry see Field 5G.
W90-08442

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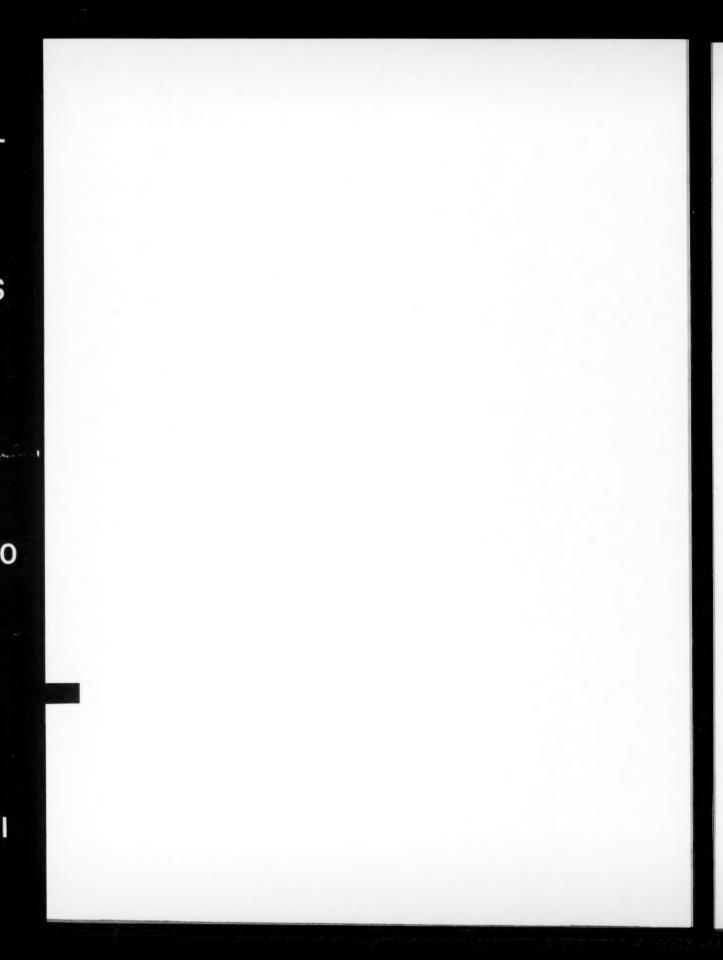
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